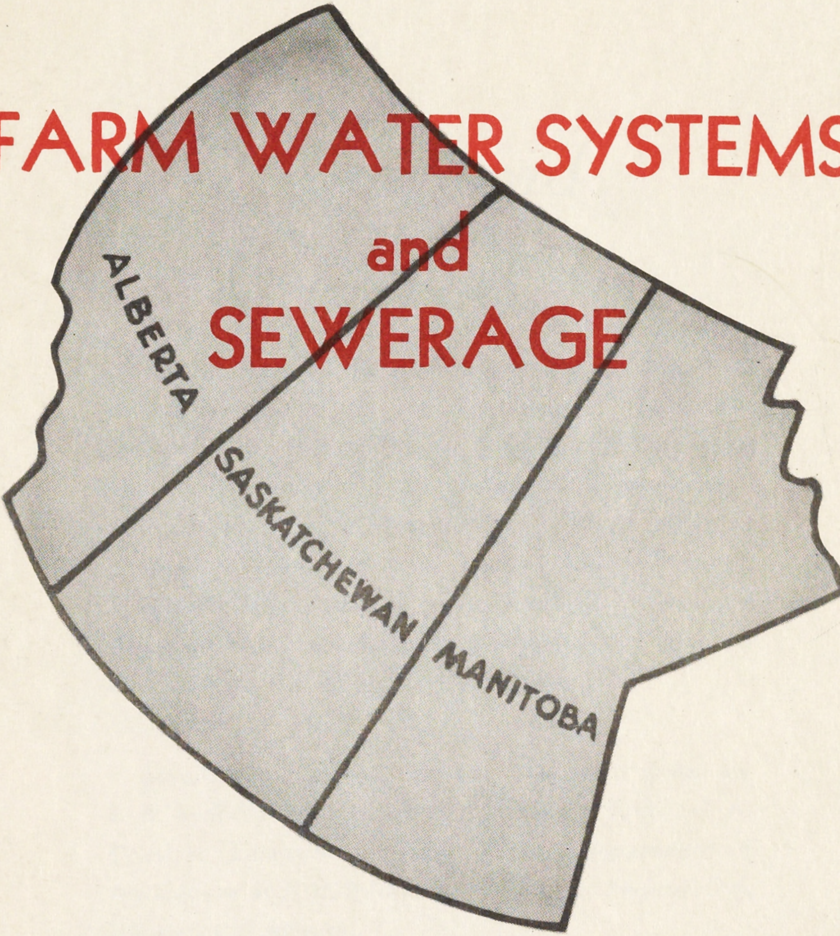
FARM WATER SYSTEMS and SEWERAGE



Prepared under the auspices of the Prairie Rural Housing Committee sponsored by the Governments of the Provinces of Manitoba, Saskatchewan and Alberta, and by Central Mortgage and Housing Corporation.

Foreword

This booklet has been prepared under the auspices of the Prairie Rural Housing Committee sponsored by the Governments of the Provinces of Manitoba, Saskatchewan and Alberta, and by Central Mortgage and Housing Corporation of the Dominion Government. It was written by Mr. P. Bouthillier, S.M., as part of a program of study of rural sanitary facilities in the Prairie Provinces, carried out in the Civil Engineering Department at the University of Alberta and financed by the Prairie Rural Housing Committee.

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FARM WATER SYSTEMS AND SEWERAGE

SOURCES OF WATER

The most common sources of water on farms are:

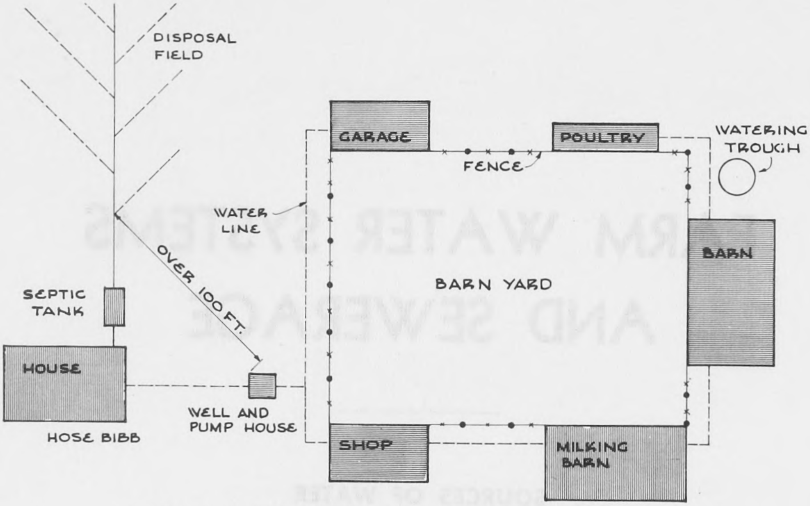
1. Wells
2. Springs
3. Surface Waters (lakes and streams, dugouts)
4. Rain Water.

The great majority of farms have a well as a source of water. Well water is often high in dissolved salts but is usually free of disease-producing bacteria. In most cases where well waters are contaminated, it is due to surface water entering at the top of the well.

In order to avoid contamination, the space between the dug hole and the cribbing should be filled with concrete for the first ten to twenty feet below the ground surface. Puddled clay can be used in place of concrete if concrete is not readily available. The pump platform should be made of concrete or planks covered with metal sheeting.

When locating a well, the following points should be kept in mind.

1. It should be convenient for the purpose it is to serve. If the well is close to the house, labor and pipe will be saved when running water is installed. Water lies under the ground in layers or tables. Within a circle of a few hundred



FARM WATER SUPPLY AND SEWAGE DISPOSAL

Fig. 1

yards radius, water will usually be found at the same elevation. Because of this fact, it is usually possible to drill a well where you want it.

2. Do not locate the well in a low spot where surface water will collect and form puddles around the well and watering trough.
3. Do not locate the well near an abandoned privy, cesspool, subsurface sewage drains, or in the line of drainage from a barnyard. Wells should be 50 feet* from septic tanks, 150 feet from cesspools and 50 feet from drain fields.

In some areas, deep wells will yield water which cannot be used as drinking water by man or animals because of high salt content. Experienced well diggers will often know about local conditions. For the area south of Township 32 in Saskatchewan, maps have been prepared by the Department of Mines and Resources in Ottawa, showing approximately at what depth water will be reached, and what the quality of the water will be. This information may be obtained from the municipal offices in this area.

In so-called "bad water" areas or "dry" areas, a dugout or a dam on a ravine will help to solve the water supply problem. A cistern will supply soft water at a reasonable cost.

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*The permissible minimum distance varies in different Provinces.

Shallow wells are sometimes drilled in basements. While this is not the best place for a well from the point of view of possible contamination, there is a saving in piping and pumping costs. Basement wells should have a watertight casing for ten feet of depth below the basement floor The well top is raised at least one foot above the basement floor. The drop pipe should be in short lengths so that it may be taken out should the need arise.

Digging Wells

Most wells are drilled by men who specialize in that business. Shallow wells are often dug by hand, in which case a permanent or temporary cribbing should be placed as the well is dug, in order to prevent a cave-in, and possible fatalities.

In sandy areas where a high water table exists, a driven well is an inexpensive and rapid method of reaching a safe water supply. A driven well consists of a tightly assembled pipe driven into the ground. The lower end of the pipe is fitted with a drive point and a screen. (Fig. 3)

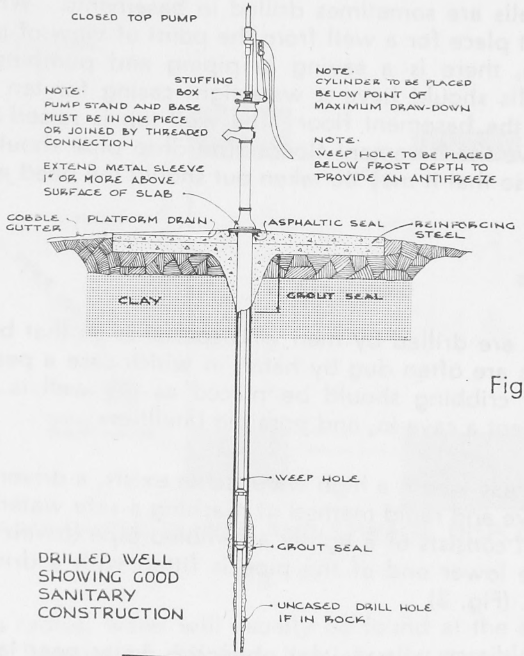
This type of well is useful for obtaining water near lakes and rivers. Since construction allows the use of a suction pump only, the depth is limited to about twenty feet below the cylinder.

The diameters of driven wells are usually from 1½ to 3 inches. The pipe used should be in sections short enough for easy driving with a sledge hammer. A cap is placed on the top end of the pipe to protect the threads. When joining the pipe sections the threads on the pipe, **not** the coupling, should be painted with pipe dope to insure an air-tight joint. (See page 45.)

Well Cribbing

Wood cribbing has been widely used for wells on the prairies. Wood will eventually decay however, unless it is continuously wet. The worst conditions for decay are alternate wetting and drying.

For wells less than twelve inches in diameter a good cribbing can be made of vitrified tile. For diameters over twelve inches, the cost of tile is excessive. By using a construction as shown in Fig. 4 an eight inch tile cribbing may be used.



DRILLED WELL SHOWING GOOD SANITARY CONSTRUCTION

Fig. 2

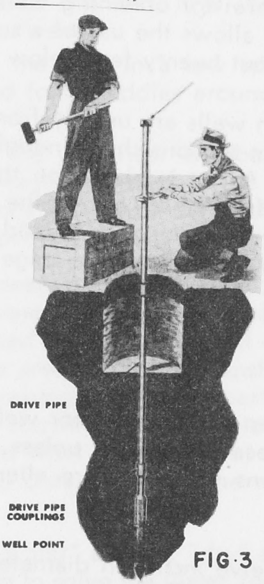


Fig. 3

FIG·3

ONE METHOD OF DRIVING A WELL

For dug wells a permanent cribbing may be made of brick or concrete blocks. It should be built in a circle and the space between the brick cribbing and the earth wall filled with gravel, except for the top 10 feet which should be filled with concrete or puddled clay.

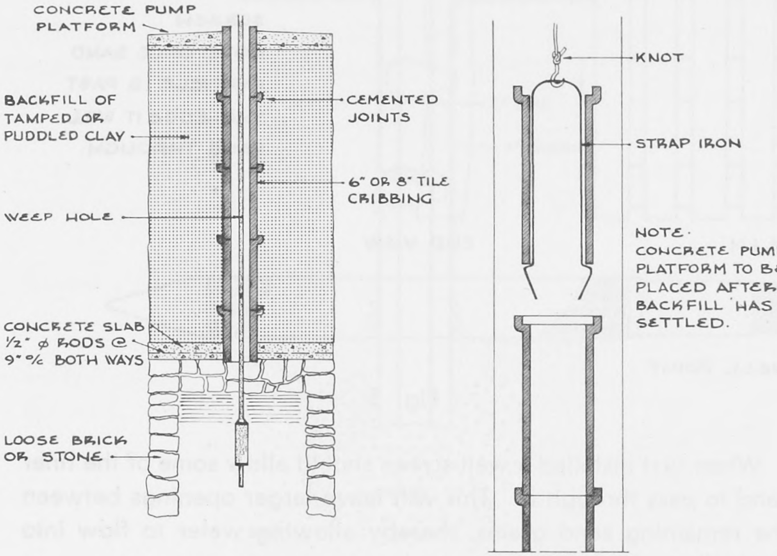


Fig. 4

Well Screens

Well screens are used in driven wells and sometimes are used in bored wells where sand tends to fill up the well. A very fine screen will keep out fine sand, but it may plug up and cut down the capacity of the well.

Roughly, a 25 gauge screen (25 openings per inch) is suitable for coarse sands and a 100 gauge for very fine sands. A slotted screen is better than one with round or square openings, since it will not plug up as quickly.

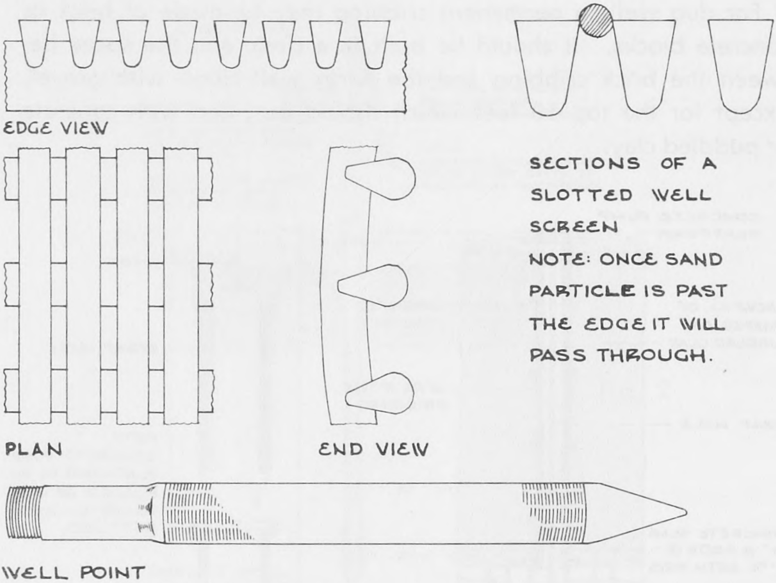


Fig. 5

When first installed a well screen should allow some of the finer sand to pass through it. This will leave larger openings between the remaining sand grains, thereby allowing water to flow into the well at a higher rate.

Well screens are used to best advantage in gravel or coarse sand. In fine sands a gravel packed well is used by professional well drillers. In gravel packing the well is drilled and a casing is placed to the bottom. A small casing (two inches smaller in diameter) is then placed inside the outer casing and graded gravel one-quarter inch in diameter is placed between the two casings. A pump is placed in the inner casing and pumped at a high rate of flow in order to pump out the quicksand. As the sand is pumped out the gravel replaces it and forms a bulb around the bottom of the well. Additional gravel is added as required. The outer casing is then pulled leaving the gravel as shown in Fig. 5A.

The action of the gravel is to increase the cross-section of flow into the well, thus lowering the velocity of the water flowing through the sand. With lower velocities sand is not carried into the well — thus the well is kept from plugging up.

While the use of steel casing and pulling of outside casing may not be practical a modified procedure may be used. The main idea is to pump out sand and replace it with gravel, which forms a bulb at the bottom of the well.

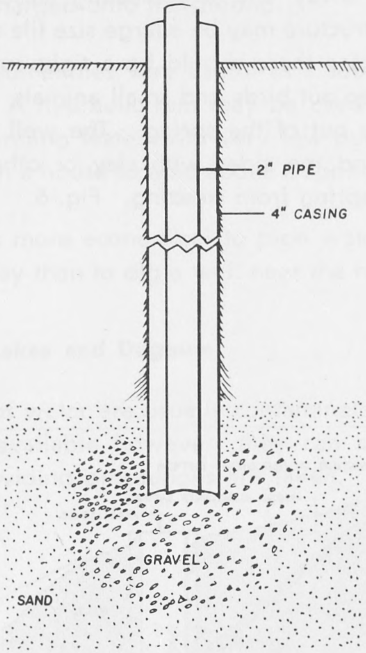


Fig. 5A

Springs

Some farmers are fortunate in having flowing wells, or springs, as a source of water. Spring water is often regarded as being pure. Frequently however, spring waters are found to be contaminated. Sometimes this is due to the fact that they have been misused.

The quality of water from springs in sandstone, sand or gravel is usually better than that from springs occuring in limestone. The reason for this is that contaminated water can travel a long distance in fissured limestone without being purified. A muddy water occurring after a heavy rain indicates possibility of pollution. If there is any doubt as to the quality of spring water that is to be used for domestic purposes, write to your Provincial Department of Health and they will forward a sterilized container for the collection of a sample for analysis.

If tests show spring water is of good quality and it is of sufficient quantity, steps should be taken to protect it from contamination. The area around the spring should be fenced off to keep stock away and a protecting structure built over the spring. This structure may be a large size tile or a concrete pipe or box. In any case there should be a tight cover over the spring in order to keep out birds and small animals, and also to prevent bailing directly out of the spring. The well structure should be insulated around the sides with clay or other suitable material to protect the spring from freezing. Fig. 6.

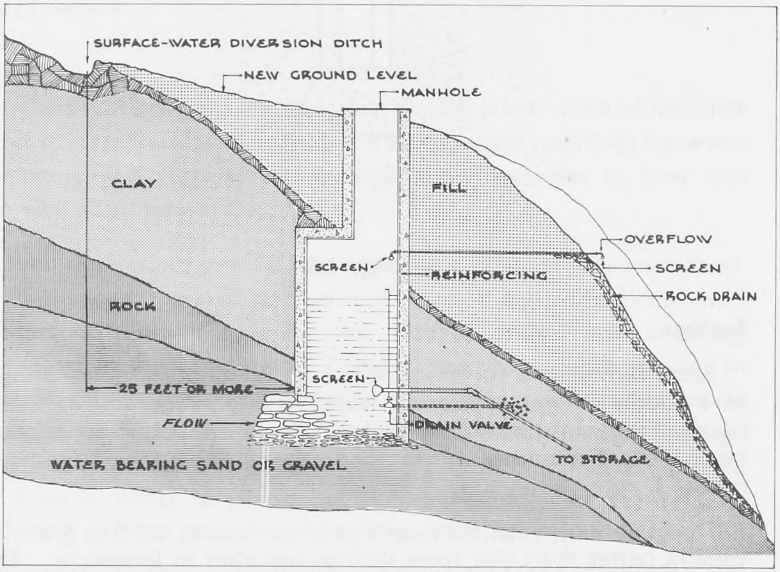


Fig. 6

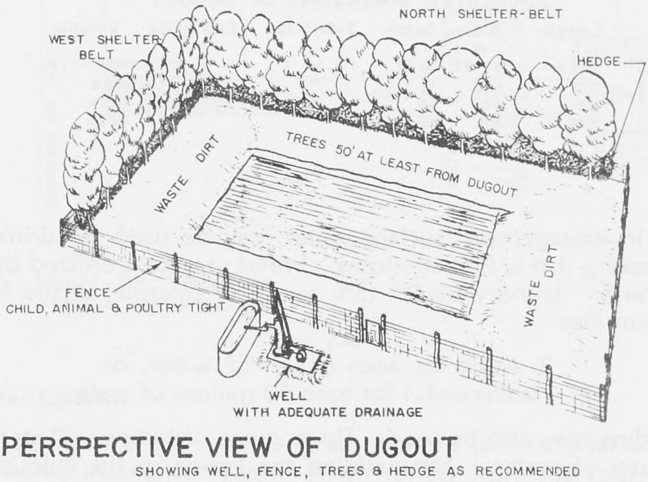
Sometimes spring water is used to keep cream and milk cool on farms. The water from the overflow pipe should flow into a box or trough with a waste pipe installed at the opposite end. The waste water should be taken fifty feet or more from the spring before being discharged onto the ground.

Springs are sometimes very useful as a source of power for pumping water. A hydraulic ram may be used for this purpose (See Fig. 15). Running water with very low pumping costs may thus be installed in a house located above a spring.

It is sometimes more economical to pipe water from a spring some distance away than to dig a well near the house.

Streams, Ponds, Lakes and Dugouts

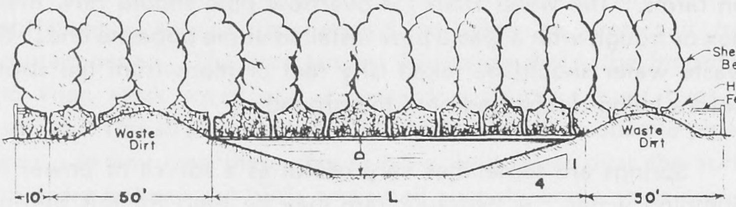
Those sources of water are usually contaminated. Where other sources are not available however, they can supply water for domestic use, providing precautions are taken.



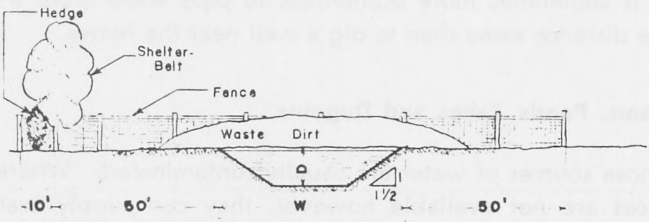
PERSPECTIVE VIEW OF DUGOUT

SHOWING WELL, FENCE, TREES & HEDGE AS RECOMMENDED

FIG. 7



SECTION THROUGH LENGTH OF DUGOUT



SECTION THROUGH WIDTH OF DUGOUT

SUGGESTED DIMENSIONS OF DUGOUT

Length L	Width W	Depth D	Side Slope	End Slope	Volume
120 Ft.	60 Ft.	10 Ft.	1½ to 1	4 to 1	1555 cu.yds.
120	60	12	"	"	1728
120	60	14	"	"	1904
150	60	10	"	"	2055

Fig. 7

In emergencies, surface water may be used for drinking and cooking if it is first sterilized. Water may be sterilized by adding "Perfex" laundry bleach (5% available chlorine) in the following quantities:

> 2 drops for each gallon of water, or
> 1 teaspoonful for each 50 gallons of water.

Iodine may also be used. Three drops of iodine will sterilize one quart of water. After adding the iodine or the chlorine, allow the water to stand for thirty minutes before using. With turbid or colored waters larger quantities of chlorine or iodine may be required. A slight taste of the chemical after fifteen minutes contact generally indicates effective disinfection.

Boiling water for at least ten minutes will also ensure a safe drinking water.

A more permanent method of purifying water is to use the soil as a filter. This may be done by driving or digging a well beside the surface water supply. In most areas using surface storage it will be necessary to use a sand filter between the storage and well.
See Fig. 7A.

For this type of filter gravel containing some sand should be used. The sand should be fine enough to pass through an ordinary window screen. Filters cannot be depended upon to remove all the bacteria present, but they will remove a large percentage.

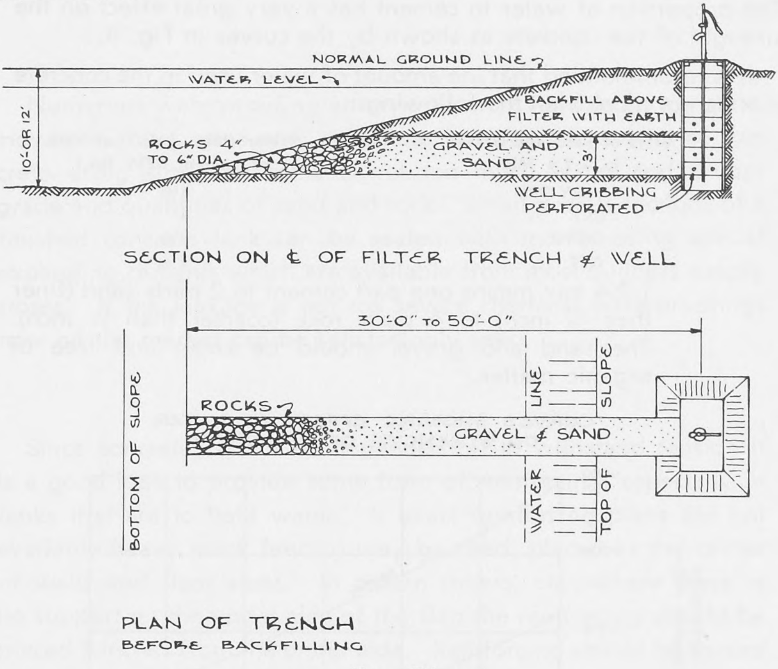


Fig. 7A

Rainwater Cisterns

The average rainfall over a great portion of the prairies is about twelve inches per year. When runoff from the roofs of buildings is collected a substantial amount of very soft water can be stored. If properly filtered (and preferably chlorinated), rain-water can be used for cooking and drinking as well as for washing and laundering.

Cisterns are often used to collect rainwater, and farmers who have installed them are usually satisfied that the cost of construction has been well repaid in the amount of soft water provided.

The size of the cistern should allow for storage of one cubic foot of water for every square foot of roof area drained. The cistern is often placed in the basement to prevent freezing. It must be watertight and have a good cover on it to keep dust, mice and bugs from the water. It should be ventilated by screened vents in the cover.

CONSTRUCTION OF CONCRETE CISTERNS

For a watertight cistern good quality concrete must be used. The proportion of water to cement has a very great effect on the strength of the concrete as shown by the curves in Fig. 8.

It is recommended that the amount of water used in the concrete mix be not more than the following:

State of Sand and Gravel in 1:2:4 Mix	Water (Imp. gals. per sack of cement 87½ lbs.)
VERY DRY	4½
DRY	4
DAMP	3½
WET	3¼

1:2:4 mix means one part cement to 2 parts sand (finer than ¼ inch) to 4 parts rock (coarser than ¼ inch). The sand and gravel should be clean and free of organic matter.

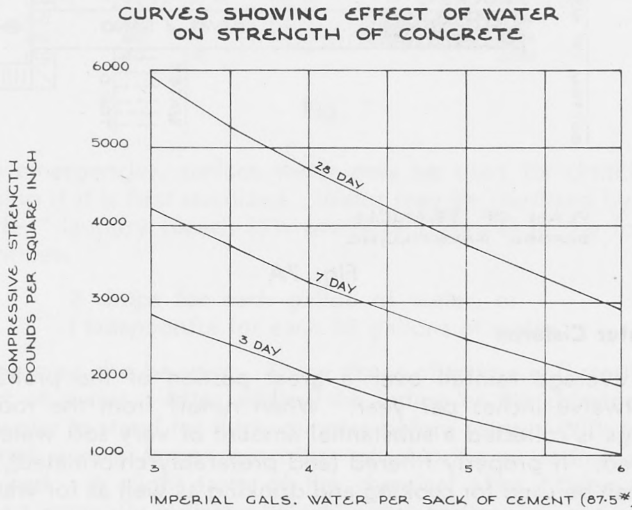


Fig. 8

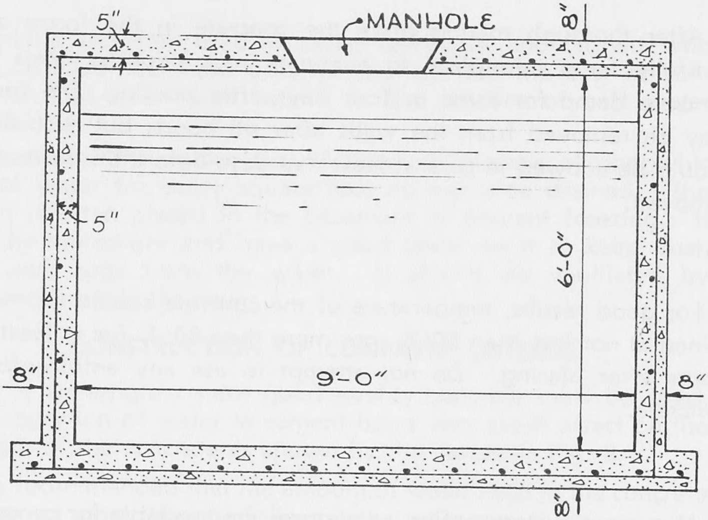
After thorough mixing place the concrete in the forms and carefully tamp into place to eliminate rock pockets. Keep the concrete damp for three or four days after pouring. The forms may be removed from the walls after 48 hours, but roof slabs should be allowed to cure at least five days before the forms are removed.

For good results, temperature of the concrete should be maintained at not less than 50°F., nor more than 80°F. for at least 72 hours after placing. Do not attempt to use any anti-freeze in concrete.

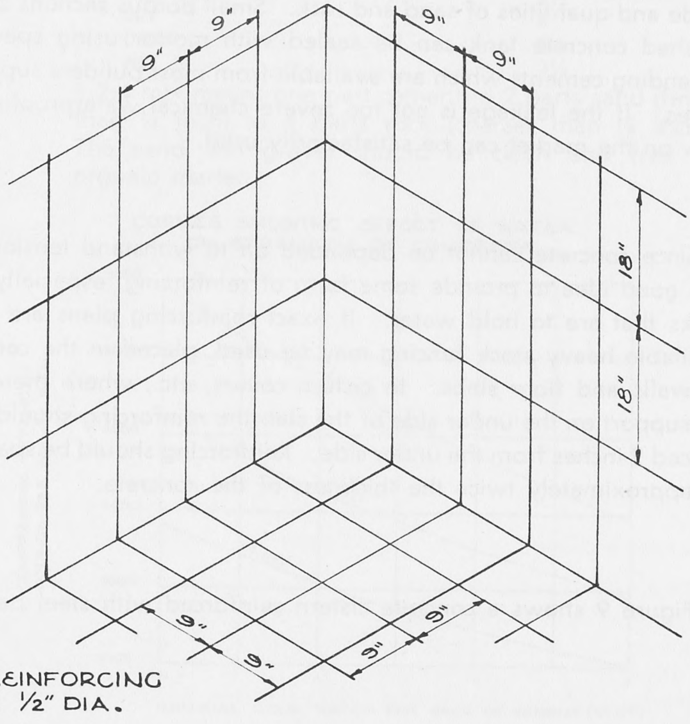
Numerous waterproofing admixtures are available for concrete. However, these are a poor substitute for a proper quality of concrete using sufficient cement, not too much water and proper grade and quantities of sand and rock. Small porous sections of a finished concrete tank can be sealed with mortor using special expanding cements which are available from most builders supply stores. If the leakage is not too severe chemical waterproofings now on the market can be satisfactorily used.

Since concrete cannot be depended on to withstand tension it is a good idea to provide some form of reinforcing, especially in tanks that are to hold water. If exact reinforcing plans are not available heavy stock fencing may be used, placed in the center of walls and floor slabs. In cistern covers, etc., where there is no support on the under side of the slab the reinforcing should be placed 2 inches from the under side. Reinforcing should be spaced at approximately twice the thickness of the concrete.

Figure 9 shows a concrete cistern reinforced with steel bars.



3000 GALLON CONCRETE CISTERN



ALL REINFORCING BARS ½" DIA.

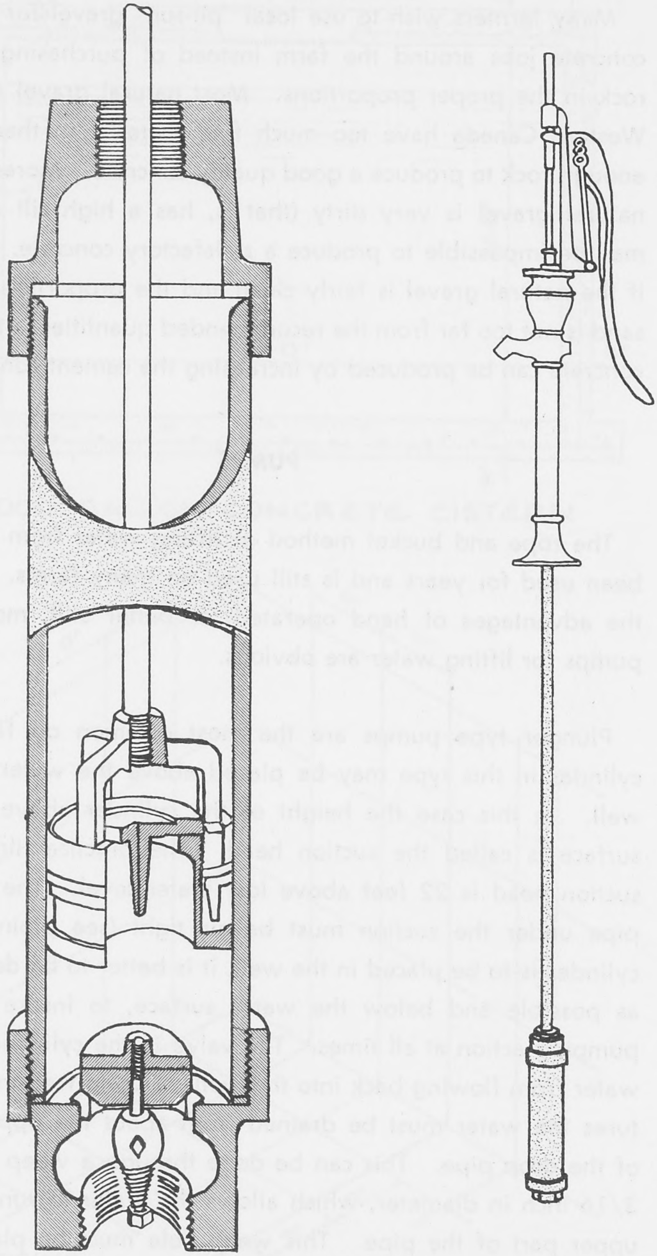
Fig. 9

Many farmers wish to use local "pit-run" gravel for such small concrete jobs around the farm instead of purchasing sand and rock in the proper proportions. Most natural gravel deposits in Western Canada have too much fine material in them and not enough rock to produce a good quality concrete. Moreover, if the natural gravel is very dirty (that is, has a high silt content), it may be impossible to produce a satisfactory concrete. However, if the natural gravel is fairly clean and the proportion of rock to sand is not too far from the recommended quantities, a satisfactory concrete can be produced by increasing the cement content.

PUMPS

The rope and bucket method of lifting water from a well has been used for years and is still used on many farms. However, the advantages of hand operated, or better still, motor driven pumps for lifting water are obvious.

Plunger type pumps are the most common on farms. The cylinder in this type may be placed above the water level in a well. In this case the height of the cylinder above the water surface is called the suction head. The practical limit for the suction head is 22 feet above low water level. The portion of pipe under the suction must be air tight (see piping). If the cylinder is to be placed in the well, it is better to be down as low as possible and below the water surface, to insure a positive pumping action at all times. The valve in the cylinder keeps the water from flowing back into the well. During freezing temperatures the water must be drained from about the upper ten feet of the drop pipe. This can be done through a weep hole about 3/16 inch in diameter, which allows the water to run out of the upper part of the pipe. This weep hole must be placed above the cylinder, and cannot be used on any suction piping.



PUMP CYLINDER

Fig. 10

The plunger type pump may be used with power produced by hand, windmill, gasoline engine, or electric motor. When electric motors are used with single action pump cylinders, some form of load balancing is required to prevent an irregular load on the motor. Overload switches should be installed to avoid burning out the motor. The quantity of water pumped varies directly with the number of strokes, the length of stroke and the area of the cylinder. (See Table 2.)

TABLE 2

Capacity of Single Acting Cylinders

Inside Diam. of Cylinder Inches	Length of Stroke Inches 6	8	10	12
	Imp. Gallons per stroke			
1½	.038	.051	.064	.077
1¾	.052	.069	.087	.104
2	.068	.091	.113	.136
2¼	.086	.114	.143	.172
2½	.107	.141	.177	.212
2¾	.128	.171	.214	.257
3	.153	.204	.255	.306
3¼	.179	.239	.299	.359
3½	.208	.275	.347	.427
3¾	.239	.318	.398	.478
4	.272	.362	.453	.544

If the top of a plunger type pump is made tight it can be used as a force pump. That is, it may be used to pump water to a tank above the pump, or to a pressure tank.

Smaller plunger type pumps are often used on automatic pressure tank systems. Here they are placed horizontally and may be double acting, pumping water on both the forward and reverse strokes of the cylinder. They are not recommended for suction lifts of over 18 feet.

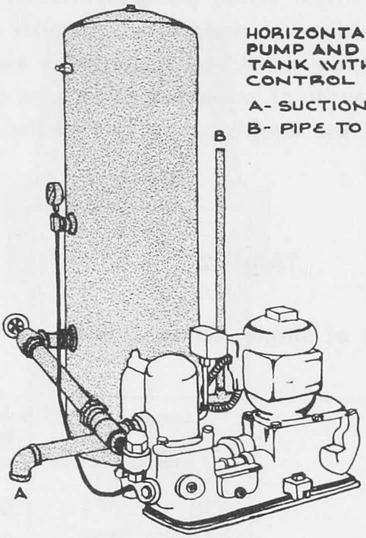


Fig. 10A

Centrifugal Pumps

Centrifugal pumps can be used either with a gasoline engine or an electric motor. The small centrifugal pumps now on the market are more efficient than earlier types.

The practical suction lift on centrifugal pumps is limited to about 10 feet. Most installations use horizontal centrifugal pumps (the drive shaft is horizontal).

The centrifugal pump operates smoothly, with little noise and a steady discharge. Moreover, closing the outlet from the pump will not cause breakage as it would in positive displacement type of pumps such as the plunger type with no relief valve.

The vertical centrifugal pump is especially adaptable to pumping irrigation water, where large quantities of water are required at a low head. It is also used as a sump pump.

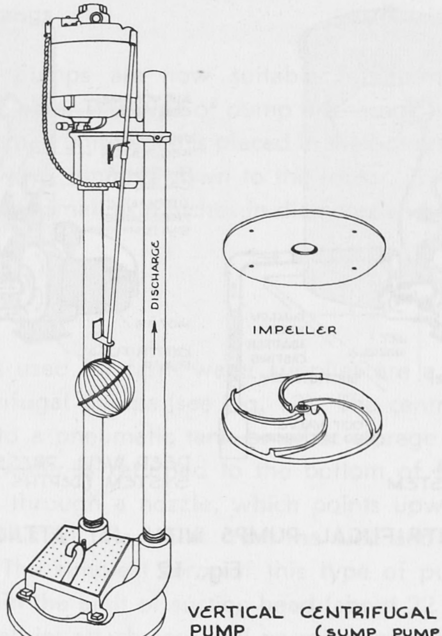


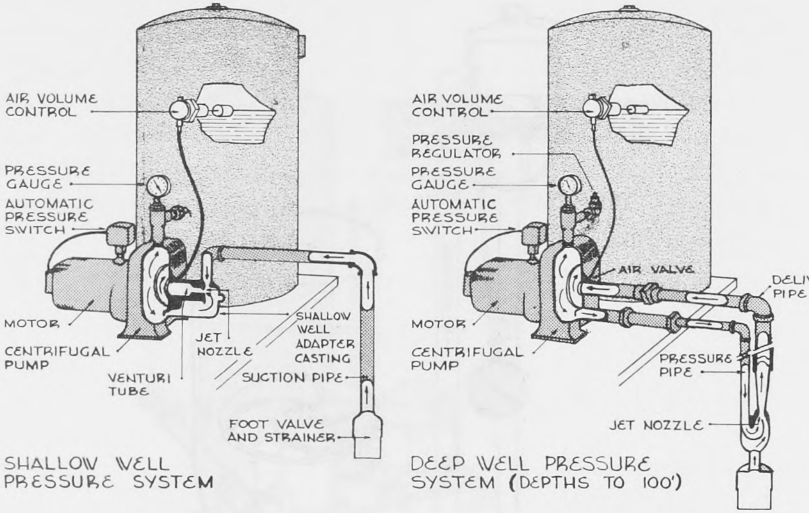
Fig. 11

To work efficiently a centrifugal pump **must** operate at the speed and capacity for which it is designed. The following rules apply approximately to a pump on a fixed installation:

1. The amount of water pumped will be proportional to the speed of the pump. That is, if the speed of the pump is doubled, twice as much water will be pumped.

2. The change in pressure will be proportional to the square of the speed. That is, if the speed is doubled, the pressure will increase by four times.

3. The power required will be proportional to the cube of the speed. That is, if the speed is doubled, eight times as much power is required.



CENTRIFUGAL PUMPS WITH JET ATTACHMENT

Fig. 12

Deep Well Turbine Pumps

Deep well turbine pumps are mainly used for municipal water supplies such as for towns and villages where a much greater quantity of water must be pumped as compared to a farm water supply at capacities less than about 100 g.p.m. This type does not operate very efficiently. It also costs considerably more than a plunger type pump.

The deep well turbine pump may be thought of as a vertical centrifugal pump with small impellers that will fit inside the well casing. Several impeller blades are used to improve the efficiency. Their diameters may be as small as six inches.

Close coupled turbine pumps are often used in irrigation work where large quantities of water are required. Their capacities range from 15 to 30,000 g.p.m. They may be powered by gasoline engines or electric motors. When a gasoline engine is used a right angle gear drive is installed.

Submersable Pumps

Submersable pumps are now suitable for farm use where electricity is available. This type of pump has the motor and impeller built in one small unit which is placed in the bottom of the well, with insulated wires running down to the motor. This pump may be used in wells as small as 4 inches in diameter and at any depth.

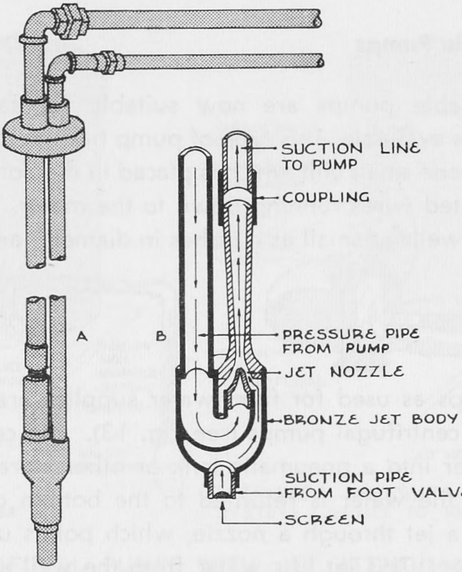
Jet Pumps

Jet pumps as used for farm water supplies are a combination of jet and centrifugal pumps (see Fig. 13). The centrifugal pump forces water into a pneumatic tank or other storage and a small portion of the water is returned to the bottom of the well and ejected as a jet through a nozzle, which points upward into the suction pipe. This jet lifts water from the well and carries it up to the pump. The simplest form of this type of pump will lift water only within the limit of suction head (about 22 feet). However, a deep well jet attachment will permit pumping water from wells up to depths of 100 feet. The addition of the jet to shallow well units also increases the efficiency, in this case the jet is placed near the impeller, **no**t in the well.

An important advantage of a jet pump is the fact that the pump does not have to be placed over the well. This means that you can have your pump in the basement, pumping from a well up to 100 feet in depth and 100 feet or so from the house. A disadvantage is that double piping is required.

When the pump is placed away from the well, all horizontal piping should slope upward toward the pump. The suction pipe which draws water from the well is usually larger than the return pipe. A jet pump for a farm system may be installed in a well as small as four inches in diameter.

The jet is subject to wear when pumping water containing sand or silt particles. Always make provision for taking out the piping in the well, by putting in unions at accessible points at the house and at the well.

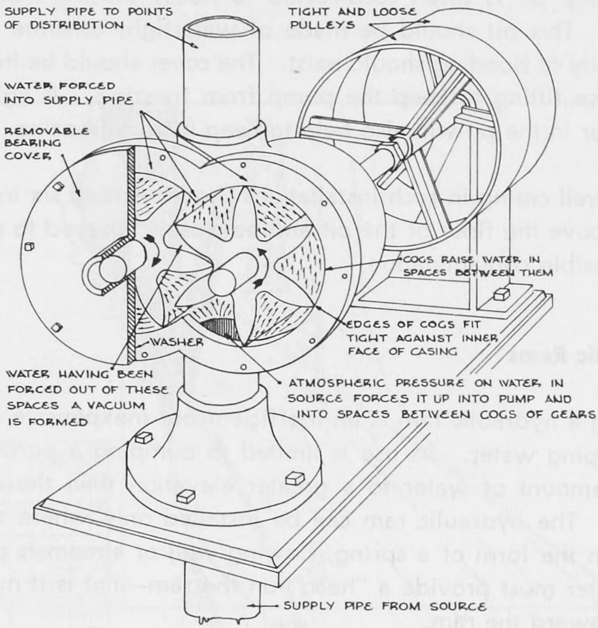


A-PIPING FOR DEEP WELL JET ATTACHMENT
B-DETAIL OF JET
Fig. 13

Rotary Pumps

Rotary pumps (gear pumps) are sometimes used on farms. They are limited to a 20-foot suction lift and are not suitable for pumping water carrying sand or silt because the parts are subject to heavy wear.

This type of pump is more frequently used to pump liquids such as gasoline, coal oil, molasses, vinegar, etc., out of barrels. For pumping water they have little or no advantage over a power driven centrifugal pump, and the parts are likely to need replacement sooner than with a centrifugal pump.



ROTARY PUMP

Fig. 14

Propeller Pumps

For pumping very large quantities of water only a short vertical distance (irrigation), propeller pumps are very satisfactory. The capacities of these pumps vary from 1,000 to 100,000 gallons per minute, operating under heads of from 5 to 25 feet.

Location of Pumps

Possible locations for a pump will depend upon the type of pump used. Unless the pump and motor or engine are located in the basement, a pump house or pit should be constructed for their protection from the weather and to insure long trouble-free service.

A well insulated pump house is recommended for an engine driven pump. Be sure to run exhaust pipes out to the atmosphere. A trap door located directly above the well will come in handy if the drop pipe or valve leathers have to be replaced.

A pump pit is often constructed to house electric motors for pumps. This pit should be made of watertight concrete and no possibility of flooding should exist. The cover should be insulated and close fitting to keep the pump from freezing. A light bulb or heater in the pit will also help to keep it from freezing.

The well casing in such installations should extend six inches or more above the floor of the pit and be closely covered to prevent any possible contamination.

Hydraulic Rams

Using a hydraulic ram is an inefficient but inexpensive method of pumping water. Its use is limited to pumping a portion of a larger amount of water to a greater elevation than the original source. The hydraulic ram can be installed only where running water in the form of a spring, flowing well or stream is present. This water must provide a "head" on the ram—that is it must run down toward the ram.

Hydraulic rams will not stop and start automatically. Therefore they are only suitable for pumping to a tank (gravity or pneumatic) which has an overflow provided. They are rather noisy in operation.

The following information is required to determine the size of ram for any particular installation:

1. Quantity of water in gallons per minute available at ram.

2. Quantity of water in gallons per day desired for use.

3. Available fall in feet from source of supply.

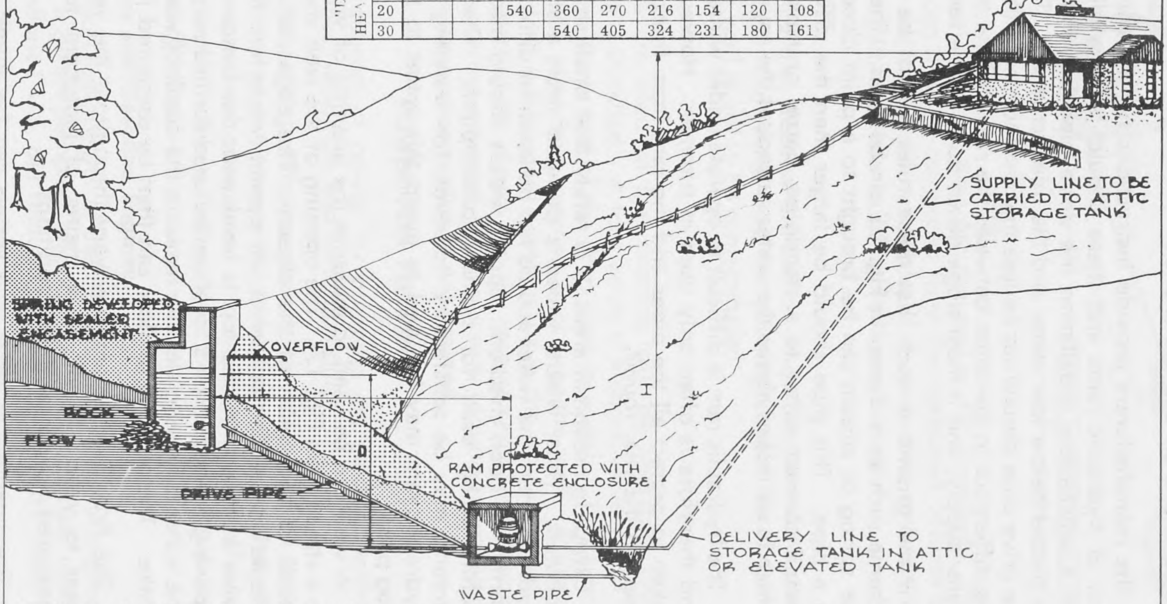
4. Horizontal distance in feet in which this fall (3) occurs.

5. Length of delivery pipe in feet.

6. Lift required in feet from the ram to the supply tank.

Table of approximated delivery capacities giving gallons per 24 hr. day, delivered for each gallon of spring water flowing per minute at various drive heads and delivery heights.

"D" DRIVE HEAD IN FEET	"I" DELIVERY HEAD IN FEET: 10	20	40	60	80	100	140	180	200
4	432	216	108	64	48	38			
6		324	162	108	72	58	41	32	
8		432	216	144	108	78	55	42	
10		540	270	180	135	108	69	53	48
14			378	252	189	151	108	75	66
20			540	360	270	216	154	120	108
30				540	405	324	231	180	161



NOTE: Length of drive pipe should never be less than 5, not more than 10 times the head of fall (D) under which ram is placed regardless of delivery head (I).

HYDRAULIC RAM

Fig. 15

With this data a supplier of the type of pump can advise on the proper size or whether an installation is impractical. Fig. 15 shows a typical hydraulic ram installation, together with some useful data on performance and installation.

The manufacturers provide instructions for the correct installation of hydraulic rams and these should be carefully followed. For a satisfactory installation the drive pipe (see Fig. 15) should be placed below low water and the inlet screened. The length of the drive pipe should not be less that five nor more than ten times the difference in elevation between the ram and the surface of the water supply, and it must slope down towards the ram.

If the ground is such that these rules cannot be followed, a scheme such as is shown in Fig. 16 can be used. The water from the spring or stream can be brought to a point close to the ram in a pipe. This pipe should be larger than the drive pipe, and should connect either to a standpipe, barrel or tank, the top of which is six inches above the water surface at the source.

The hydraulic ram is difficult to operate under winter conditions, and therefore is often only used in summer. However, if care is taken to protect all the pipes and the ram from freezing it can be used all the year round.

Except in mountain areas, it is rarely that small streams are not polluted. Thus, where water is pumped from a stream with a hydraulic ram, the water should not be used for drinking unless its purity has been checked. Spring waters should also be checked before being used for human consumption. The water from streams may be satisfactory however, for watering stock, and a hydraulic ram may be used to pump this water to the barn and hog pens.

A weir can be used to measure the quantity of water available in a stream (see Fig. 17). The opening of the weir should be two-thirds of the width of the stream. The edges of the opening should be bevelled as shown. At a point two to four feet upstream drive a stake until the top is level with the bottom of the weir opening. A carpenter's level can be used for this purpose. When the water is flowing steadily measure the depth of water above the stake. The quantity of flow can then be computed from Table 4.

The flow in a stream may vary throughout the year and from year to year. It will be a matter of judgment to correct the measured flow to average conditions.

The quantity of flow in a spring can be found most readily by damming up the spring with dirt and sod, and allowing the water to flow out through a pipe in the dam. This flow can be

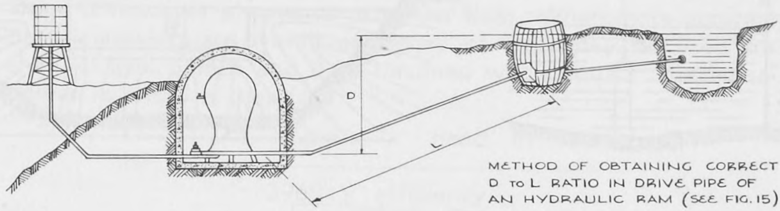


Fig. 16

caught in a pail, and the time for the pail to fill recorded. The rate of flow can then be computed from the measured volume of the pail and the time. For example, if it takes two minutes to fill a 5 gallon pail, the flow is 2.5 gallons per minute.

Priming Pumps

Many pumps that depend on suction must be primed to start them operating. The water used for priming should be of good quality, if the well is not to be contaminated.

Foot Valves

Foot valves are used so that priming will be necessary only when a pump is installed. A foot valve is a check valve which is installed at the lower end of the drop pipe in a well. This keeps the water in the pipe from running back into the well. Plunger type pumps with submerged cylinders have the equivalent of a foot valve as part of the pump. In the case of centrifugal pumps located at the surface a heated pump house is required to prevent freezing since the suction piping is not drained.

POWER FOR PUMPING

The usual sources of power for pumping are electric motors, gasoline engines, windmills and hand pumping.

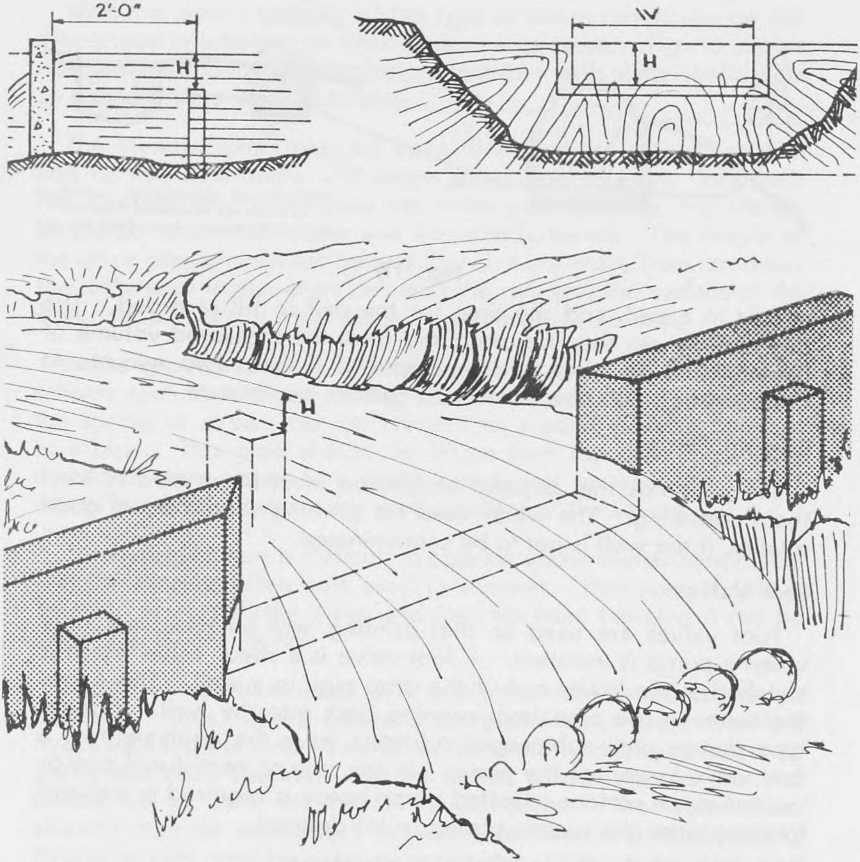
Electric motors and gasoline engines are adaptable to all types of pumps. They must however be belted correctly so that the centrifugal and turbine pumps run at correct speeds for efficient operation. Windmills are suited only to the plunger type pump with a vertical cylinder.

Electric Motors and Gasoline Engines

The theoretical horsepower of electric motors or gasoline engines required for a given pumping load can be determined by multiplying the gallons (°U.S. per minute) pumped by the total head in

*1 Imperial gallon equals 1.2 U.S. Gallons.

Note: U.S. gallons are used here because most pumps are rated in U.S. gallons per minute.



H	TABLE NUMBER 4							
Inches	0	1/8	1/4	3/8	1/2	5/8	3/4	7/8
0	0.00	0.01	0.05	0.09	0.14	0.19	0.26	0.32
1	0.40	0.47	0.55	0.64	0.73	0.82	0.92	1.02
2	1.13	1.23	1.35	1.46	1.58	1.70	1.82	1.95
3	2.07	2.21	2.34	2.48	2.61	2.76	2.90	3.05
4	3.20	3.35	3.50	3.66	3.81	3.97	4.14	4.30
5	4.47	4.64	4.81	4.98	5.51	5.33	5.51	5.69
6	5.87	6.06	6.25	6.44	6.62	6.82	7.01	7.21
7	7.40	7.60	7.80	8.01	8.21	8.42	8.63	8.82
8	9.05	9.26	9.47	9.69	9.91	10.13	10.35	10.57
9	10.80	11.03	11.25	11.48	11.71	11.94	12.17	12.41
10	12.64	12.88	13.12	13.36	13.60	13.85	14.09	14.34

Table 4 gives the flow in cubic feet per minute for various depths (H) in inches over a weir 1 ft. wide. Illustration above shows method of installing weir.

Fig. 17

feet and dividing this by 3,960. This assumes 100% efficiency. There is however always some power loss. When more accurate data is lacking an overall efficiency of 0.50 may be used for shallow well pumps and 0.30 for deep well pumps. The horsepower required is therefore

$$HP = \frac{\text{U.S. g.p.m.} \times \text{head in feet}}{3960 \times \text{efficiency}}$$

The head in feet is the height to which the water is to be lifted above the water surface in the well. One very important addition must be made to this difference in elevation. This occurs where water is pumped into a tank under pressure (pneumatic tank). Pumping into a tank under pressure is equivalent to raising water to the same height to which the water can be forced out of the tank by the pressure. For every pound per square inch (p.s.i.) pressure in a tank water could be forced up 2.3 feet.

For example, a tank under 40 p.s.i. pressure will force water up to a height of 92 feet. (40 × 2.3). It will shoot a stream of water out of a hose to almost this height.

Thus, for every p.s.i. pressure in the tank 2.3 feet must be added to the difference in elevation between the tank, and surface of the water being pumped from.

A correction must also be made for head loss due to friction in the pipe. This is an appreciable factor if the pipe is not large enough to take the required flow of water through it. Not less than one inch pipe should ever be used from a pump. A good rule to follow is to figure that the velocity in the pipe is about four feet per second and less than eight feet per second.

The following table will indicate the size of pipe to use:

TABLE 5

Pipe Size

Flow	1″		1¼″		1½″		2″		2½″	
US G/m.	Vel.	H/100′	Vel.	H/100′	Vel.	H/100′	Vel.	H/100′	Vel.	H/100′
5	1.86	3.25	1.07	.84	0.79	.40				
10	3.72	11.7	2.14	3.05	1.57	1.43	1.20	.50	.65	.17
20	7.44	42.0	4.29	11.1	3.15	5.20	2.04	1.85	1.3	0.61
40			8.58	40.0	6.30	18.8	4.08	6.60	2.6	2.2
80					12.60	68.0	8.16	23.7	5.2	7.9
120									7.8	12.0

H/100′ = head loss in feet of water due to friction in 100 feet of pipe.

Vel. = velocity of flow in feet per second.

Example—Flow is 40 U.S. gallons per minute. Going horizontally across from a flow of 40 U.S. g.p.m. we find that a velocity of 4.08 ft. per second will be obtained using a two-inch pipe. This size should be used.

It will be noted from Table 5 that the head losses due to friction increase very rapidly with increases in velocity. This results in waste of power. For example, pumping 80 U.S. g.p.m. through 200 feet of 1½ inch pipe rather than a 2½ inch pipe will be equivalent to pumping the water 120 feet higher. The motor or engine would have to be 1.2 HP larger. If the electricity is worth 2c/K.W. Hour—this is 1½c more for each hour of pumping. The use of a larger size pipe would be well justified by the saving in power.

The average farm pump will pump about five gallons per minute. A one-inch diameter pipe will handle this without much head loss. For flows of 10 to 20 gallons per minute a 1¼ inch or 1½ inch pipe is recommended.

Example of Computation of Power Requirement

A pump is to pump 5 U.S. gallons per minute. The pump is 100 feet above the water surface (plunger type, jet type or deep well turbine). The water is pumped through 200 feet of one-inch pipe to a pressure tank in which the maximum is to be 40 pounds per square inch. The tank is 15 feet above the pump head. What size of motor is required?

First, compute the total head against which the pump must operate.

SECTION	Difference in Elevation or Equivalent
Water surface to pump	100 ft.
Pump to tank	15 ft.
Pressure in tank (40 × 2.3)	92 ft.
Friction loss from Table 5 (2 × 3.25)	6.5 ft.
TOTAL	213.5 ft.

Assuming an efficiency of 40 percent the horsepower required is

$$\text{Horsepower} = \frac{5 \times 213.5}{3960 \times 0.4} = 0.65 \text{ H.P.}$$

For a gasoline engine the overall efficiency is closer to 30 percent. Thus the required horsepower would be

$$\text{Horsepower} = \frac{5 \times 213.5}{3960 \times 0.3} = 0.9 \text{ H.P.}$$

This would require a ¾ horsepower motor or a one horsepower gasoline engine.

Electric motors come in sizes of ¼, ⅓, ½, ¾, 1, 1½, 2, 3 and 5 horsepower.

TABLE 6

U.S. Gals. per min.	Total Working Head in Feet											
	50	60	70	80	90	100	125	150	175	200	300	400
	Theoretical Horsepower											
1	.01	.02	.02	.02	.02	.03	.03	.04	.05	.05	.08	.10
2	.03	.03	.04	.04	.05	.05	.06	.08	.09	.10	.15	.20
3	.04	.05	.05	.06	.07	.08	.10	.11	.13	.15	.23	.30
4	.05	.06	.07	.08	.09	.10	.13	.15	.18	.20	.30	.40
5	.06	.08	.09	.10	.11	.13	.16	.19	.22	.25	.38	.51
6	.08	.09	.11	.12	.14	.15	.19	.23	.26	.30	.45	.61
7	.09	.11	.12	.14	.16	.18	.22	.26	.31	.35	.53	.71
8	.10	.12	.14	.16	.18	.20	.25	.30	.35	.40	.61	.81
9	.11	.14	.16	.18	.20	.23	.28	.34	.40	.45	.68	.91
10	.13	.15	.18	.20	.23	.25	.31	.38	.44	.50	.75	1.00
20	.26	.30	.35	.40	.45	.50	.63	.76	.88	1.01	1.51	2.02
30	.38	.46	.53	.61	.68	.76	.95	1.14	1.32	1.51	2.27	3.03
40	.51	.61	.71	.81	.91	1.01	1.26	1.51	1.76	2.02	3.03	4.04
50	.63	.76	.88	1.01	1.14	1.26	1.57	1.89	2.20	2.52	3.78	5.05
100	1.26	1.52	1.76	2.02	2.27	2.50	3.15	3.78	4.40	5.05	7.58	10.10

To find the actual horsepower required for electric motors

Actual HP = Theoretical (from Table 6) × 2

for gasoline engines

Actual HP = Theoretical (from Table 6) × 3

If electric motors are used in sizes below ¾ H.P. the general purpose capacitor motor should be used. It is especially adapted to frequent starting and creates little radio interference. In sizes above ¾ H.P. repulsion-induction motors are recommended.

Electric motors may be controlled either by a float or pressure switch. They can be effectively grounded by using the well pipe, providing a good connection is made.

Most farmers are well acquainted with gasoline engines. They know that if the speeds are too high the engine will wear out faster. The problem is to gear them or belt them correctly for the job they are to perform.

For plunger pumps the number of strokes should be about 30 per minute. The size of cylinder and length of stroke will then determine the amount of water pumped.

Belt drives at high speeds often use "V" belts rather than flat belts, since they do away with side slippage. In all belt drives there is some slippage; thus a 10 inch pulley at 1,000 r.p.m. will turn another 10 inch pulley at about 980 r.p.m. However, in calculating sizes of pulleys this may be neglected. The speeds (r.p.m.) of pulleys on one belt will then be proportional to the diameters—i.e.

Speed of Pulley 1 × Dia. of Pulley 1 =
Speed of Pulley 2 × Dia. of Pulley 2.

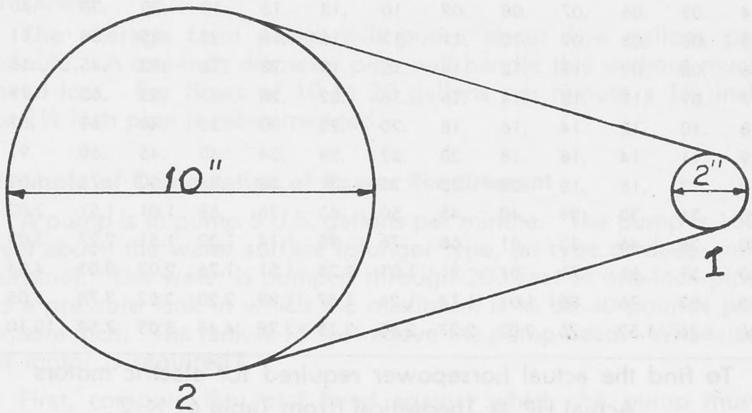


Fig. 18

For example, if Pulley No. 1 revolves at 1725 r.p.m. (this should be shown on the motor or engine plate), what is the speed of Pulley No. 2?

$$1725 \times 2 = 10 \times \text{Speed of Pulley No. 2}$$

$$\text{Speed of Pulley No. 2} = \frac{1725 \times 2}{10} = 345 \text{ r.p.m.}$$

Note: The size of pulleys for "V" belts where measured from the outside to outside of flanges is designated as O.D. (outside diameter). The effective diameter for calculating speeds is the pitch diameter, P.D. This P.D. may be found by subtracting three-quarters of the belt depth from the outside diameter.

Windmills

Windmills can be used satisfactorily for pumping water if adequate storage is provided. They can be made to operate automatically so that they will pump water whenever the tank is less than full, providing wind is available.

There are certain periods when there is not enough wind to operate a windmill and at such times it is necessary to pump water by hand or with a gasoline engine. The economy of a combination windmill and gasoline engine is doubtful so in a new installation a windmill and engine should probably not be installed. An engine alone is the best installation if an engine is to be used at all. A windmill and a portable gasoline engine will make a good combination since the engine can be used for other purposes on the farm.

Windmills are often used in pastures distant from the house, where they supply water for stock with very little attention. The tank should be large enough for a two to three days water supply for the stock using the tank.

Windmills must use a plunger type pump. The cylinder should be of the correct diameter for the size of mill wheel. Table No. 7 indicates the correct size of mill for different sizes of cylinders and pumping lifts (heads).

INSTALLATIONS

TABLE 7

Diameter of Wheel

		6 feet		8 feet		10 feet	
Lift Feet	Velocity of Wind Miles/hr.	Diam. of Cylinder	Gals. per Hour	Diam. of Cylinder	Gals. per Hour	Diam. of Cylinder	Gals. per Hour
25	10	2½″	140	3½″	320	4¼″	420
35		2	120	3	270	4	360
50		1¾	110	2¾	180	3½	305
75				2½	135	3	235
100				2	105	2½	160
125				1¾	90	2	125
25	15	3½	250	5	560	7	1,190
35		3	175	4	400	6	880
50		2½	125	3½	280	5	610
75		2	85	2¾	190	4	375
100		1⅞	60	2½	140	3½	305
125				2¼	115	3¼	250

Above table in U.S. gallons per hour.

Computations should be based on a 10 mile per hour wind.

Storage of Water

To avoid frequent starting and stopping of pumps it is adviseable to have some storage available. With hand pumping or pumping with gasoline engine or windmill at least a full day's supply should be stored. The following table will serve as a guide to water requirements.

Daily Water Requirements on the Farm	Imp. Gals.
Per person (including cooking, laundering, bath, toilet)	25
Per work horse	10
Per cow	15
hog	4
sheep	2
100 chickens	4
100 turkeys	7

Water for the Home

To supply pressure to a household plumbing system one of two systems may be used. These are classified as gravity and hydropneumatic systems.

Gravity systems still have their place in rural water supply. They are simple to install and may be used with a force pump powered by hand or windmill. They are adaptable to automatic control if electricity is available, by using a float switch in the tank. However, gravity systems are not recommended where electricity is available.

A gravity system consists essentially of an open water tank which supplies water to fixtures below it. This tank is usually located on the second floor or in the attic. If automatic control is available a tank of 50 to 100 gallon capacity will be satisfactory. Otherwise one full day's supply should be stored. This is usually computed at 25 Imp. gallons per person per day.

For a family of six a tank holding 150 gallons would be required. The tank should be located above a supporting wall so that the weight of the tank full of water (almost 2000 lbs.) will not crack plaster in ceilings, or in some cases perhaps break through the ceiling.

Provisions should be made for a ¾- or one-inch overflow which may be drained into the kitchen sink. The tank should also be placed in a sheet metal pan which will collect any water condensing on the tank walls. If this is not done the condensation may ruin wall finishes, rot timber and so forth. The tank should be covered to keep out dust, mice and bugs.

A more desirable system is one employing a pneumatic tank with automatic controls (Fig. 10A). In this case a tank of about 40 Imp. gallons has been found suitable providing automatic pumping is installed. The pump is usually of sufficient size to operate garden hoses continuously. The recommended minimum size is 5 U.S. gals. per minute. Lawn sprinklers usually require 5 gals. per minute.

PIPING

The question of what piping material to use arises whenever any plumbing is installed.

In starting it should be stated that no one kind of pipe thus far produced is perfect. Materials for practical piping include galvanized wrought iron, copper, lead, aluminum, asbestos cement, and plastic pipe.

Galvanized wrought iron pipe is the most practical. Galvanizing does not add materially to resistance to internal corrosion by water, but it is preferable on the outside of pipes. Care should be taken not to damage the coating. While galvanized pipe will corrode rapidly in most prairie soils, it can be used for underground lines if it is enclosed in 4 inch weeping tile. This type of construction will minimize corrosion, and make it possible to remove the pipe if necessary, without digging. Unions should be put in at the well and in the basement to facilitate removal of the pipe.

Copper and brass pipe have a long life and their cost is moderate; they can be used satisfactorily to convey all ordinary waters.

Lead pipe has a very long life. In very soft waters, high in carbon dioxide, there is some danger of lead poisoning. Lead was formerly used underground under conditions of severe corrosion. Lead pipe is not used today for inside plumbing.

Cement-asbestos pipe has proved very satisfactory. It is available in sizes of 2 inches and up. The connections between pipe lengths are easy to make, and the pipe will not corrode. It is not suitable, however, for piping inside the house.

Plastic pipe for water lines is now being manufactured. It has been used in some cities to carry water from the street to the house. The advantage of plastic pipe is that it does not corrode and some types are not harmed by freezing. It cannot, however, be thawed as readily as can metallic pipe. As yet plumbing codes

do not permit the use of plastic water pipe for lines inside a building. Future development may well make the use of plastic pipe advantageous.

Size of Pipe

For medium pressures (20 to 30 p.s.i.) the following minimum sizes of pipe are recommended.

Distribution Main	Line to Bathrm	Bath Tub	Lavatory*	Closet Tank	Kitchen Sink	Laundry Tub	Sill Cock for Lawn hose
¾ to 1¼"	¾ or 1"	½"	½"	½"	½"	½"	¾"

* Reduces to ⅜" at faucet.

In hot water lines near the heating element where experience has shown that scale forms with hard water, it is advisable to use a size ¼ inch larger than the above table suggests.

In general, branches longer than 25 feet or branches supplying more than two small fixtures should be ¾ inch pipe.

Plumbing

While a complete installation will require the services of a reliable plumber there is a lot of the work that can be done by the farmer himself. Repair work and water supply especially falls into this category.

All plumbing must meet the provincial plumbing codes and must be inspected. The purpose of these codes is to protect the public against inferior work and material, both of which are a menace to public health and are in the long run likely to cost more than a good initial installation. Initially they were not meant to prohibit the installation or repair of plumbing by the home owner.

By following the regulations of a good plumbing code the home owner can protect himself against

1. Contamination of the water supply.

2. Undesirable odors arising from improper trapping of fixtures.

3. Excessive maintenance cost and troubles caused by improper installation.

A Few Suggestions

Water pipes should be installed so that the water can be drained freely from the lowest point of the system. The piping should run as directly as possible, with a minimum number of bends. Be sure to set all fixtures level but with the horizontal piping sloping upwards towards the point of use (1/8 to 1/4 inch per foot).

Drain pipes from ice boxes must **not** be connected either to soil pipe or waste piping from other fixtures. They should drip into a tray so that there is an air gap between the drain and tray. This tray is trapped and drained into a sink or to a floor drain. Most ice boxes have a built-in air gap.

Do not run water supply, drains, soil pipes or vents in an outside wall. Freezing and condensation will cause trouble. One exception to this rule is a vent for a kitchen sink. If well insulated this may be put in an outside wall.

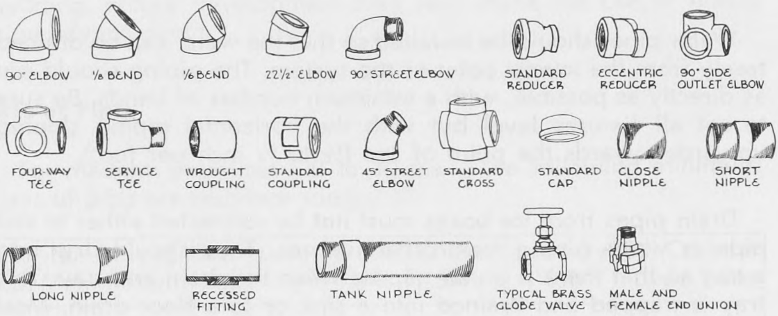
Under no circumstances should vents be run into a chimney or out through a wall instead of continuing on through the roof. If possible arrange a group of fixtures and piping along one wall. This will make for ease of installation as well as effecting a saving in pipe. See Fig. 26.

It is not permissible to instal a water closet in a sleeping room. Use extra heavy cast iron pipe for all underground drains under buildings. The extra cost may save the trouble that might occur from cracking of the pipe. Some plumbing codes allow cement-asbestos tar impregnated fibre, or tile pipe to be used under basement floors, providing it is encased in a 3" concrete shell.

Be sure the drains have sufficient slope (1/4inch per foot) and are correctly trapped and vented. **Long** drains from kitchen sinks are often sources of trouble because congealed grease and fat clog them.

Piping Pointers

Farmers installing some of their own plumbing will run into quite a few problems. Most farmers are acquainted with the tools used in handling pipe. In the following paragraphs several piping pointers are noted.



TYPICAL PIPE FITTINGS

Fig. 19

Terms

Angle valve—a globe valve having pipe openings at right angles.
Bushing—a threaded and tapped fitting which is used to reduce the size of opening of a valve or fitting.
Corrosion—deterioration of piping due to chemical action (similar to rusting).
Elbow—a fitting used to make a turn in the direction of piping.
Hose bibb (or sill cock)—an outside tap fitted with threads to take hoses for watering lawns or gardens, etc.
Female thread—internal thread in fittings, making a screwed connection.
Fitting—elbows, reducers etc. used in connecting lengths of pipe.
Fixture—sink, bath tub, water closet, etc.
Flange—a fitting used for bolting.
Gate valve—a common type of valve in large size pipes.
Globe valve—a common type of valve used in house plumbing, taps, drain cocks, etc.
Increaser—a fitting used to increase the size of pipe openings.
Male thread—external thread on pipe or fittings.
Nipple—a short length of pipe threaded at both ends.
Plug—a screwed fitting for shutting off a pipe opening.
Reducer—opposite of increaser (terms synonymous).
Return bend—a U-shaped pipe used in making return bends.
Solder joint—a type of end connection made by soldering. Generally used with copper tubing.
Street ell—elbow with one male and one female end.
Tap—tool for forming internal or female thread.
Tee—a three-way fitting shaped like a "T".
Threader—tool for cutting male thread on pipe.
Tubing—light weight pipe: copper, brass or plastic.
Union—fitting used to permit easy opening of a line.

Common Types of End Connections

Screwed end connections are by far the most widely used on piping less than four inches in diameter.

Brazed end connections are available on brass materials. An alloy brazing ring is inserted at the joint. This alloy melts and forms a tight joint when heat is applied with a welding torch.

Soldered connections are used with copper tubing. One type of soldered joint is called a wiped joint. An easier joint to make is a sweat joint.

Flared end connections may be used on valves and fittings for copper and plastic tubing up to two inches in diameter.

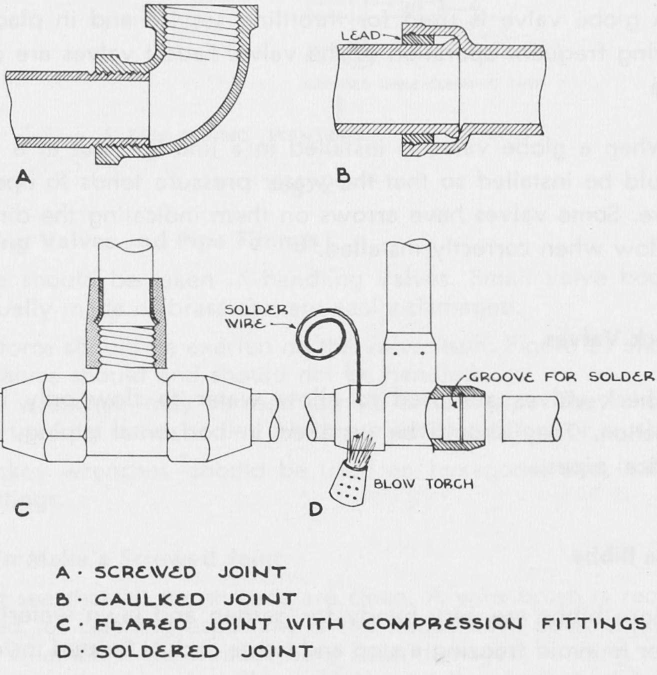


Fig. 20

Valves

The main types of valves are gate, globe and check valves. An angle valve is a globe valve constructed so that the direction of the piping is changed at the valve.

Gate Valves

Gate valves are sometimes used in plumbing, especially on lines over ¾ inch in diameter. They are not particularly suitable for throttling service (i.e. partial flows), and are not installed in places where the valve is shut off and on very often. If possible they should be installed with the valve stems pointing upward.

Globe Valves

A globe valve is used for throttling service and in places requiring frequent operation of the valve. Faucet valves are of this type.

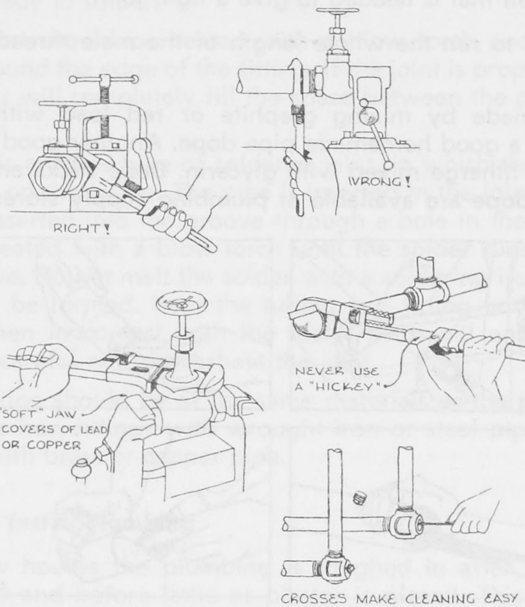
When a globe valve is installed in a line (i.e. not at a tap) it should be installed so that the water pressure tends to open the valve. Some valves have arrows on them indicating the direction of flow when correctly installed.

Check Valves

Check valves are used to allow water to flow only in one direction. They should be installed in horizontal piping, not in vertical pipes.

Hose Bibbs

Hose bibbs are very handy for garden and lawn watering. In order to avoid freezing a stop and waste cock is located inside the house at the point of takeoff from the main water line, to allow draining the hose bibb before freezing weather. The valve on the hose bibb must also be open to get complete drainage.



A FEW PIPING POINTERS

Fig. 21

Handling Valves and Pipe Fittings

Care should be taken in handling valves. Small valve bodies are usually made of brass and are easily damaged.

No force should be exerted on the valve itself. Figure 21 shows how valves should and should not be handled.

Pipe wrenches—may be used to hold or turn pipe. They should not be used on valve bodies which are easily twisted, or crushed.

Monkey wrenches—should be used on hexagonal end, valves and fittings.

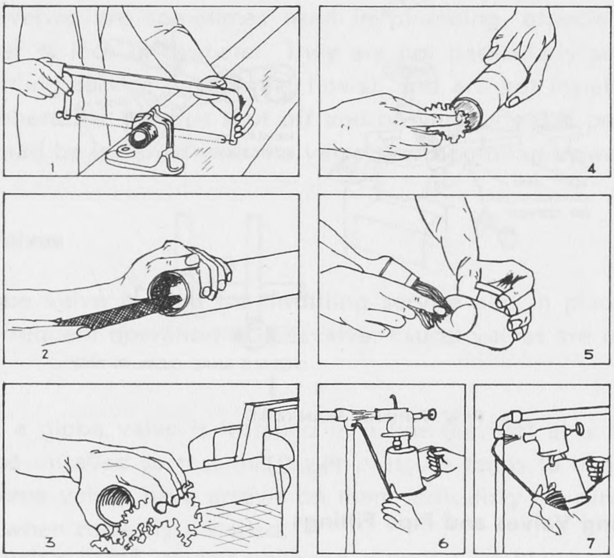
How To Make a Screwed Joint

First see that all the threads are clean. A wire brush is recommended for cleaning especially if the treads have been exposed to the weather. If the threads have been damaged, running a tap or die over the threads will usually correct the damage. A bit of thread lubricant or "pipe dope' is then put on the male thread only. The joint is then started by hand. If the threading has been good there will be no difficulty in starting the joint. The joint is

tightened by hand as far as possible and a few more turns with a wrench is all that is needed to give a tight joint.

Do not try to run the whole length of the male threads into a joint.

A paste made by mixing graphite or red lead with boiled linseed oil is a good homemade pipe dope. Another good mixture is a paste of litharge mixed with glycerin. Dope sticks and ready mixed pipe dope are available at plumbing supply stores.



1 CUTTING TUBING.
2 FILING OFF BURRS
3&4 BRIGHTENING CONTACT SURFACES.
5 APPLYING FLUX.
6&7 HEATING JOINT AND APPLYING SOLDER.

Fig. 22.

How To Make a Soldered Joint

A soldered joint is usually used with copper tubing. A sweat joint is the easiest to make.

Cut the tubing to correct length with a fine hacksaw blade. Remove all burrs with a file or scraper. Then clean the outside end of the tubing and the inside of the valve or fitting with a fine emery cloth.

A coating of soldering flux is then applied evenly over the contacting surfaces. The tubing is slipped into the fitting and

rotated once or twice in order to spread the flux evenly. The joint is then ready to solder.

The joint should be heated with a blow torch and the solder fed in around the edge of the fitting. If the joint is properly heated, the solder will completely fill the space between the pipe and the fitting.

There is another type of soldered joint, in which the fitting has a groove on the inside. The pipe is inserted in the joint and solder wire is inserted into the groove through a hole in the fitting. The joint is heated with a blow torch until the solder runs freely into the groove. Do not melt the solder with a soldering iron, as a poor joint will be formed. Heat the tubing and fitting until the solder flows when in contact with the metal. This will ensure a good joint. Be careful not to overheat the joint.

The fitting should be of the same materials as the pipe; that is, malleable iron fittings with wrought iron or steel pipe and brass fittings with brass or copper pipe.

When To Install Plumbing

In new houses the plumbing is roughed in after the framing is erected and before lathe or plaster is placed. This will permit the piping to be concealed without breaking through plaster or other wall finishes. This is true for waste plumbing (sewage and other drains) as well as water lines.

Roughing in measurements may be secured from the dealer from whom you are buying your sinks, toilet and bath tub. These vary somewhat with different manufacturers. Typical dimensions are shown in Fig. 23.

If dimensions are measured closely the pipe may be cut and threaded by the supplier or in a town shop and then brought out to the farm. A good rule in placing a kitchen sink is to have it at a height at which the housewife can place her hands flat on the bottom of the sink without bending. If a cupboard is built under the sink, toe space should be provided at the bottom of the cupboard. Easy access for cleaning out the trap should be provided.

One important point in placing faucets is to have the faucet high enough above the rim of a fixture so that at maximum water level the faucet will be 1½ to 2 inches above the water. This will prevent back syphonage and possible contamination of the water supply.

Hot Water

People installing plumbing will usually want to have a hot water system. A hot water tank of 30 or 40 gallons will supply hot

water throughout most of the day even though a fire is not maintained constantly. A good layer of insulation around the tank and hot water lines will keep loss of heat down to a minimum, thereby supplying more hot water and cutting down heating costs.

Hot water tanks should be equipped with pressure relief valves. A temperature relief valve is also recommended. With thermostatically controlled, electric or gas operated hot water tanks, a high limit control or fusible link thermostat set at 205°F. can replace the pressure and temperature relief valve.

Do not neglect to put in a gate valve in the cold water line to the hot water tank. This will make repairs to the tank or heating coils possible without shutting off all the cold water supply.

Some farm homes have furnaces in the basement. These can be utilized to heat water in wintertime, but some other means of heating water must be used in summer. The kitchen range or a small gas heater is commonly used for this purpose.

In almost all cases the water is warmed by heat transfer through a coil, which is placed either in the kitchen range, a furnace, or a gas or oil heater. Some farms now use propane gas at reasonable cost. This is ideal for heating water and for light cooking.

The heating coil in small gas heaters is usually made of copper and is shaped like a coil spring.

Heating elements in ranges and furnaces are usually fabricated and are called water backs. Most ranges make provision for such installation. The pipe should be installed so that there is a continuous slope upward from the cold water to the hot.

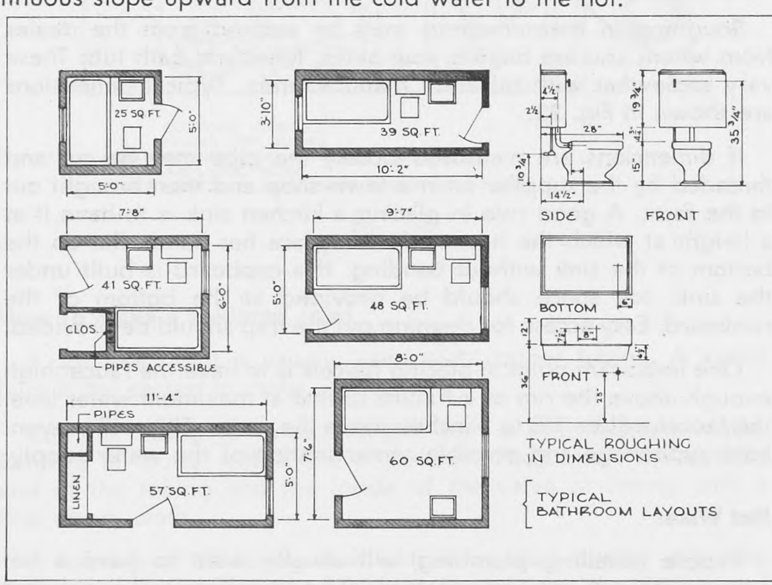


Fig. 23

Figure 24 shows a boiler connected with a kitchen range, a gas heater, and a furnace. This is a very economical combination for the average farm home.

Hot water tanks may be placed above or on the same floor as the heating element. They cannot be placed below it. This applies to pressure systems as well as gravity systems. They can be placed some distance from the heating unit, but the closer the tank is to the heating unit the better will be the circulation with less chance of boiling in the coil.

When electric power is available it provides a very convenient but more costly means of heating water. The unit is automatically controlled by a thermostat. The tank should be well insulated to avoid heat losses. The tank can be located in the basement, thus saving space on the main floor.

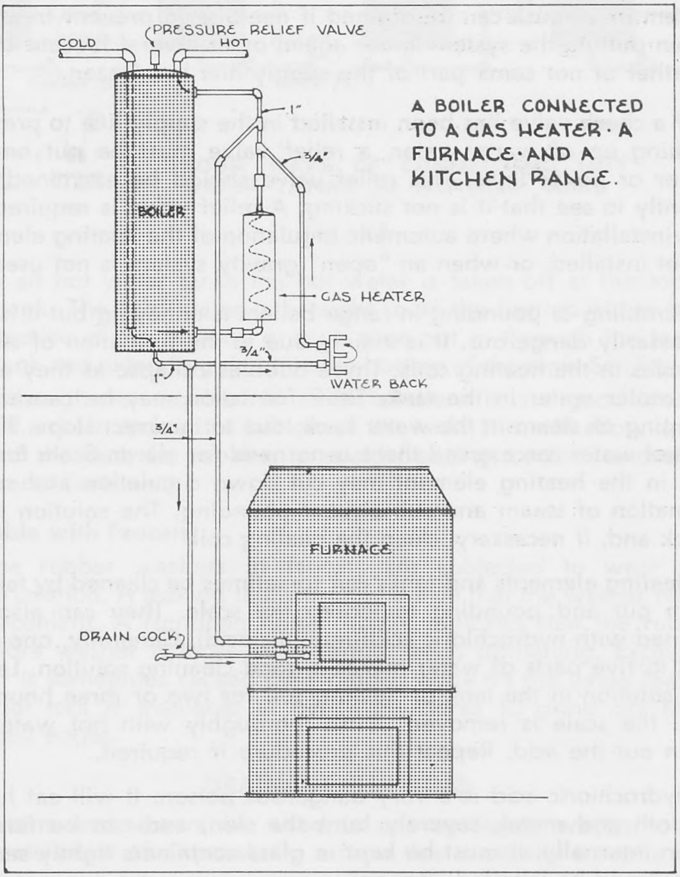


Fig. 24

Caution

Serious explosions have occurred because the expansion of steam and hot water was not allowed for in the heating system. The tank is usually built to withstand pressures of about 85 pounds per square inch. Much higher pressures than this can be produced if water is heated in a confined space. This situation may result from one or more of the following conditions:

1. Frozen or scale-bound pipes.
2. Closing of a valve on the service or cold water branch that feeds the boiler, or using a check valve on this line.
3. The sticking of a relief valve.

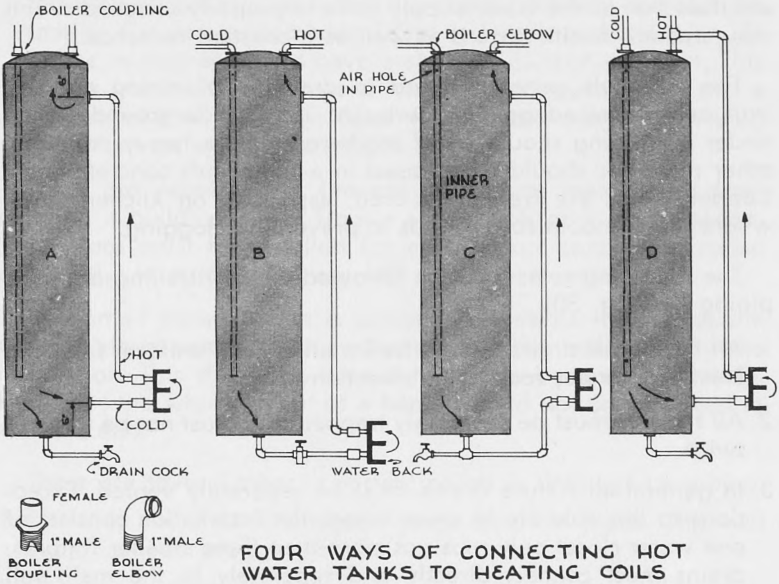
Freezing will occur in winter if a house is left unheated for a few days. Drains should be installed whereby the whole piping system in a house can be drained if need be to prevent freezing. When putting the system in use again, open several faucets to see whether or not some part of the supply line has frozen.

If a check valve has been installed in the supply line to prevent backing up of warm water, a relief valve must be put on the boiler or boiler lines. This relief valve should be examined frequently to see that it is not sticking. A relief valve is required on any installation where automatic regulation of the heating element is not installed, or when an "open" gravity system is not used.

Rumbling or pounding in range boilers is annoying but it is not necessarily dangerous. It is mainly due to the formation of steam bubbles in the heating coils. These bubbles collapse as they enter the cooler water in the tank. Their formation may be caused by trapping of steam in the water back, due to incorrect slope. If the heated water can expand there is no need for alarm. Scale formation in the heating element may cut down circulation and cause formation of steam and subsequent pounding. The solution is to check and, if necessary, clean the heating coil.

Heating elements and tanks can sometimes be cleaned by taking them out and pounding to loosen the scale. They can also be cleaned with hydrochloric acid (muriatic acid). Generally, one part acid to five parts of water makes a good cleaning solution. Leave this solution in the tank or heating coil for two or three hours or until the scale is removed. Rinse thoroughly with hot water to clean out the acid. Repeat this procedure if required.

Hydrochloric acid is a very dangerous poison. It will eat holes in cloth and metal, severely burn the skin, and can be fatal if taken internally. It must be kept in glass containers tightly sealed and should be labelled "Poison".



FOUR WAYS OF CONNECTING HOT WATER TANKS TO HEATING COILS

Fig. 25

In all hot water tanks the hot water is taken off at the top of the tank. The cold water is brought in at the bottom either by a connection at the bottom, or by a pipe put in through the top of the tank and extending down to the bottom of the tank. See Fig. 25.

Although not required in all installations it is a good idea to install a drain cock at the bottom of the tank. This will allow draining of the tank for repairs, to avoid freezing, or for removal of sediment (iron rust).

Trouble with Faucets

The rubber washers in faucets are subjected to wear and deterioration. A leaking tap is usually a sign that the washer needs replacement. A rumbling noise usually indicates that the rubber or fibre washer is loose and merely needs tightening. Excessive wear is sometimes caused by a ragged edge on the valve seat. A special tool is available at hardware stores to grind off these ragged edges.

DRAINAGE PLUMBING

Drains and sewers are used to convey liquid wastes to the ultimate point of disposal. On a farm this is usually a septic tank or a seepage pit.

The correct installation of drainage piping is even more important than that of the water supply since improperly installed drains may create a health hazard as well as a constant nuisance.

The materials generally used in drainage plumbing are cast iron or galvanized genuine wrought iron. Underground piping under a building should be of medium or extra heavy cast iron; other materials should be encased in a three inch concrete shell. Copper drains are frequently used, especially on kitchen sinks, where their smooth surface aids in preventing clogging.

The following rules must be followed when installing drainage piping (see Fig. 30):

1. All horizontal drains should be installed on a uniform fall of at least ¼ inch per foot in the direction of flow.
2. All fixtures must be separately trapped, but must not be trapped twice.
3. In general all fixture drains must be separately vented. Exceptions to this rule are in cases where the installation consists of one water closet only plus not more than three smaller fixtures; drains must connect directly and separately to the main soil

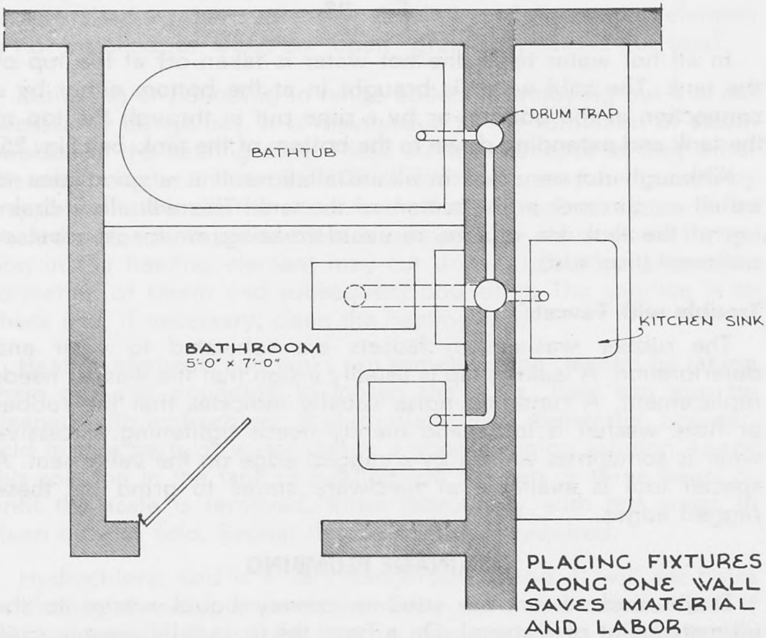


Fig. 26

stack at a point above or at the toilet bend. A requirement for this type of construction is that the drains from any one of these smaller fixtures be not over 5 feet in length and not over 1½ inches in diameter, and have a slope of ¼ inch per foot. This allows installation of a water closet, bath, wash basin and a kitchen sink without the need for separate vents, providing these fixtures are located on one floor.

Traps are necessary to prevent odors and toxic gases from entering a building either from a septic tank or a public sewer. Vent pipes must be installed for each fixture (except as stated previously) in order that traps will retain their water seals.

In a small installation it is sometimes possible to arrange the fixtures along one wall or on both sides. This will simplify the installation. This should be kept in mind when planning a house. However, the whole layout of a home should not be sacrificed to this one end.

There are several other important points in drainage plumbing.

1. Use only recessed (drainage) fittings on drain pipes. This will avoid frequent plugging of drains.
2. Changes in direction of drainage piping should be made with Y branches and a 1/16, 1/8 or 1/6 bend. This permits drains to be easily cleaned out.
3. Install cleanouts at all changes in direction to facilitate cleaning of plugged drains.
4. Never connect a waste pipe to any other pipe by boring or tapping or by using a saddle. Always use fittings and correct joints.
5. Wherever a toilet is installed the house drain must be at least 4 inches in diameter.
6. Every plumbing installation must have a soil stack. It is usually a cast iron pipe not less than 3 inches in diameter extending from the house drain up through the roof. The top section of pipe which passes through the roof is called the vent terminal and is made one inch larger in diameter than the lower sections.

The soil stack acts as a vent for sewer gases and must not be trapped. It should run vertically to a height at least 6 inches above the highest fixture it serves. It can then be taken off at an angle and turned up through the roof.

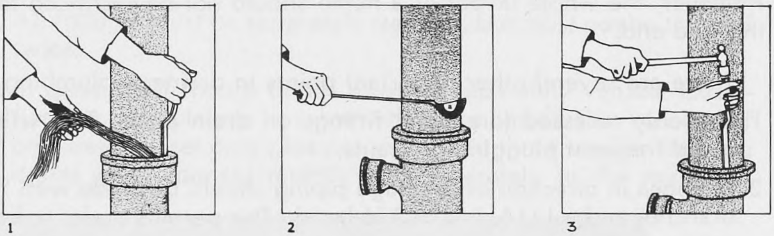
Joints in all parts of the drainage and venting system must be air and water tight. This means leaded joints must be used where soil stacks and house drains are of cast iron pipe. Threaded joints

correctly made and tightened are used with galvanized wrought iron pipe and sometimes with brass piping. Soldered joints must be used on any concealed joints in copper tubing. Unconcealed joints in copper tubing may be of the flared type.

How To Make a Leaded Joint

A prime requisite for a satisfactory plumbing job is the skill to make a good lead joint. With cast iron bell and spigot pipe a lead joint must always be used.

The first step in making a lead joint is to place the spigot end of a pipe section into the bell (hub) end of the next pipe. The pipe is always placed so that at the junctions the flow will be from the spigot into the bell. This is done automatically when making a vertical joint.



STEPS IN MAKING A CAULKED JOINT

Fig. 27

Oakum is then packed in the hub tightly to within ¾ of an inch to one inch of the top of the bell. A tool called a yarning iron such as shown in Fig. 27 is used in doing this.

The next step is to pour molten lead into the joint until the lead is even with the top of the hub. The lead should be heated over a plumber's furnace, a blowtorch, or a coal fire, to a point where a piece of stick is charred when dipped into the lead.

There are two precautions which should be taken in handling lead in addition to the ordinary care necessary with any hot liquid.

1. Heat your ladle before dipping it into the lead. A cold ladle may cause dangerous sputtering of the hot lead.
2. Do not pour lead into a joint (or any other place) that has water in it.

Serious injuries to hands and face may result from not taking proper precautions in handling the molten lead.

After the lead is poured into the joint and has cooled, use a hammer and caulking tool to pack the lead and oakum into the joint to make it air and water tight. Do not drive hard in any one spot but tap lightly around the joint a few times before caulking tight. Hammer each edge of the joint rather than make one deep groove in the middle of the lead in the joint.

Horizontal joints are caulked in a similar fashion, the only difference being that a runner is used to hold the molten lead in the joint till it is set. A clay dam may be used if only one or two horizontal joints are to be made.

In some cases making a horizontal joint can be avoided by first making up one or more sections and then putting the jointed sections in place.

Information on making screwed and soldered joints is given on pages 45 and 46 respectively.

Installation of Plumbing

Generally if a complete plumbing installation is made at one time the drains and soil pipe are roughed in first. The hot and cold water pipes are put in next followed by the fixtures (basin, sink, toilet, etc.)

Vertical stacks are usually run in partition walls using 2 × 6 studs. Studs may be notched but should be reinforced with metal plates if the cut is more than one-half the depth of the member.

In roughing in plumbing it is customary to begin with installation of the drainage system. The vertical sections of the soil stack may be of 3 inch cast iron. The toilet bend and house drain (the horizontal drain from the soil stack) should be 4 inches in diameter.

Tile, cement asbestos or asphalt composition pipe must* not be used for soil stacks or vent lines. No appreciable saving in cost is possible by the use of these as substitutes for cast iron pipe.

Begin your installation by putting in the house drain and then the soil stack. The section of pipe from the soil stack to the septic tank can often be wholly or partially prejointed to avoid making lead joints.

The change in direction from the horizontal to vertical is made with a combination "Y" and eight bend—see Fig. 30. This permits installation of a cleanout with a brass plug which can be screwed out should the drain become clogged.

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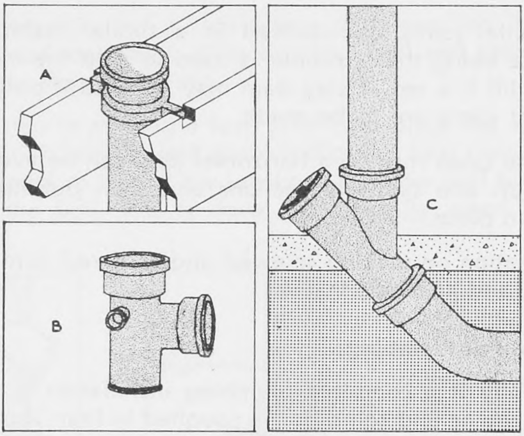
* Not permitted by plumbing codes.

The sanitary tapped Tee (See Fig. 28) which serves to connect the toilet bend and the bath drain to the soil stack is then held in place or fastened temporarily to find what length of pipe is necessary between the tee and the "Y" bend. Measure this distance. Be sure to allow for the depth of the hub and the slope of the house drain.



A · SUPPORT FOR SOIL STACK.
B · SANITARY TAPPED TEE WITH A LEFT HAND SCREWED OPENING.
C · TEE "Y" WITH CLEANOUT AT BASE OF SOIL STACK.

Fig. 28

A piece of soil pipe is then cut to this length. Standard or medium weight cast iron pipe may be cut by making a groove completely around the pipe with a three cornered file. The pipe is then tapped with a hammer until it breaks at the cut.

To cut extra heavy soil pipe, mark the pipe where it is to be cut. Lay the pipe across a piece of 2 × 4 timber with the mark over the center of the 2 × 4. Then make several cuts around the pipe with a hammer and cold chisel, gradually increasing the depth of cut with heavier hammer blows. The pipe will break off before the cut is made all the way through it.

The toilet bend is then caulked into the tapped Tee, and the Tee is then caulked into the cut section of pipe which in turn is caulked into the Y at the base of the stack. Make sure the toilet bend is well supported in the correct direction and at the correct elevation. Horizontal pipes should be supported by strap iron hangers or other substantially constructed supports. This takes care of the toilet and bathtub drainage.

The sanitary tapped Tee may have either a left- or a right-hand opening. If the same stack is to take a basin and sink drain a double tapped Tee is installed at the correct elevation for taking these wastes. This means installing a short section of C.I. pipe above the Tee taking the toilet and bath wastes. Above this sink or basin connection (if installed) the soil stack which now acts only as a vent is continued on through to the roof. At the roof an increaser is put in to increase the pipe size by one inch. The increaser passes up through the roof.

Experience has shown that to avoid trouble with ice formation the terminal should extend only one to three inches above the roof. Lead roof flashing is used to make the terminal water tight.

The basin and sink drains can then be installed. These correspond in size to the tapped opening in the cross Tee that has been installed. The wash basin drain may be 1¼ inches in diameter. The sink drain should be 1½ inch pipe. In each case the size of the trap corresponds to the size of the drain. In all installations the traps should be made accessible for cleaning. A slip joint on the fixture side of the trap can be used to take up small differences in elevation.

The bath tub drains into the sanitary Tee into which the toilet bend is caulked. Note that the bath drain enters at either the same elevation or above the toilet connection. The trap for the bath tub is often a drum type trap or a simplex "P" trap, and provision must be made to allow easy access for cleaning. See Fig. 29 and 30.

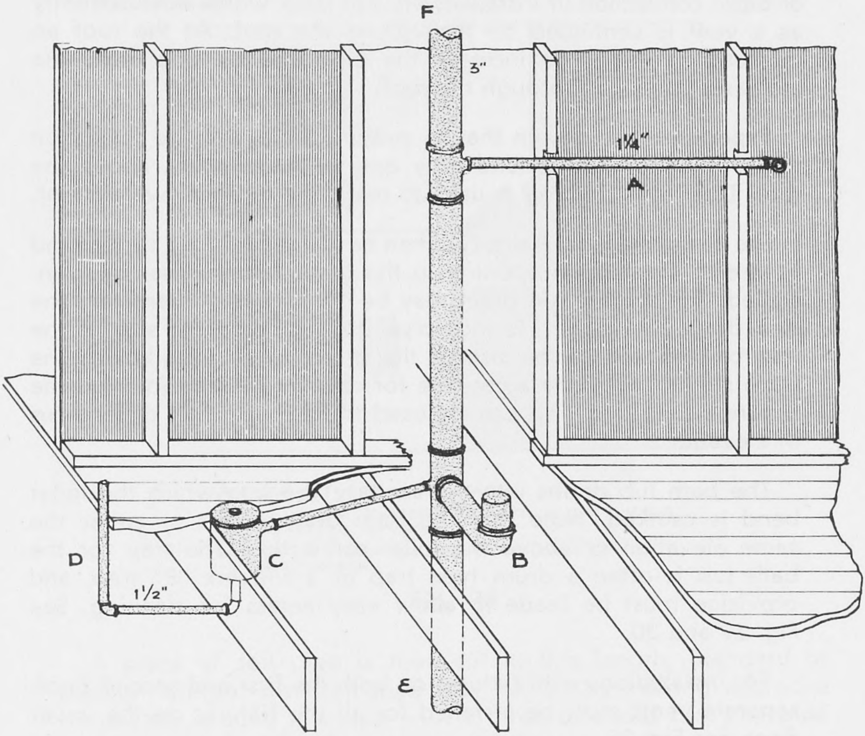
For installations with fixtures on both the first and second floor, separate vents must be installed for all the fixtures on the lower floor. See Fig. 30.

The variations in piping layouts do not permit a detailed description of re-vented systems.

When the drainage system is complete it should be tested for leaks. All branches are plugged at the end nearest the fixture and the house drain is also plugged. The whole drainage system is then filled with water and inspected for leaks. If some leaks show up they should be repaired and the test repeated.

House Sewer

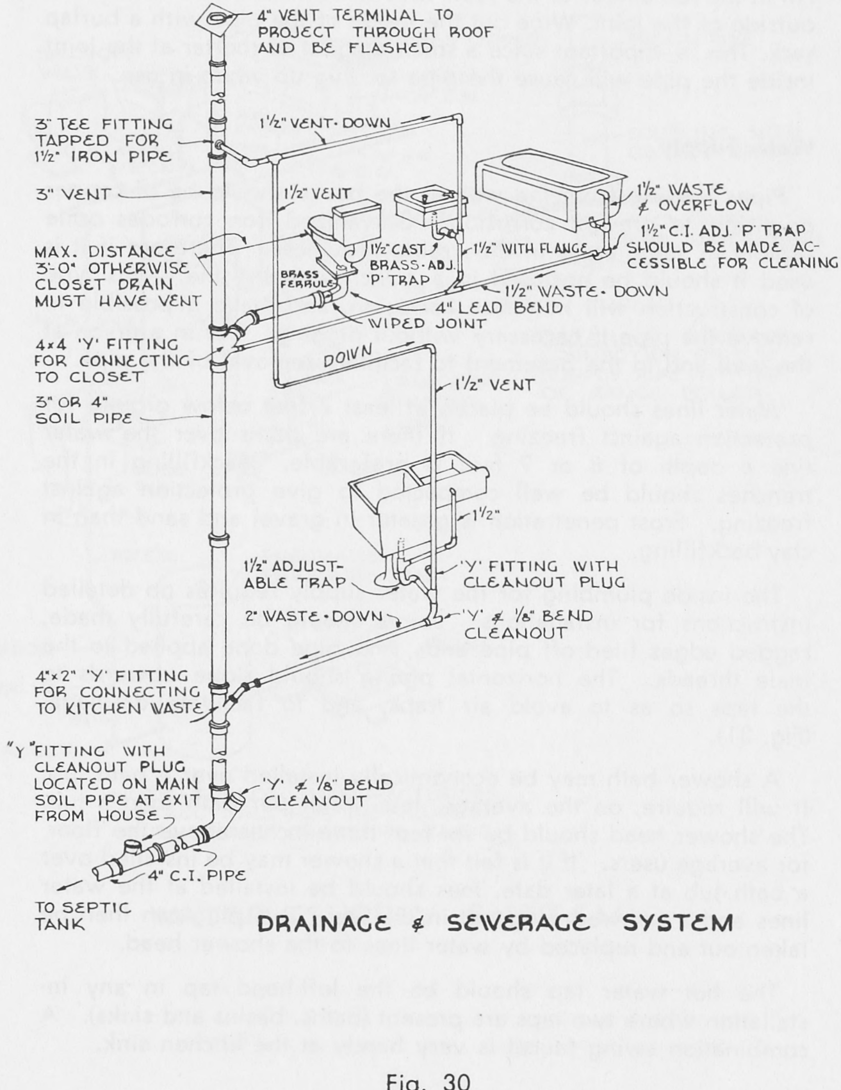
The house sewer is the pipe leading to disposal from a point 3 feet outside the building. (Inside the building this is called the house drain.) The house sewer may be of cast iron, tile, cement-



A · BASIN DRAIN
B · TOILET BEND
C · DRUM TRAP — ("P" TRAP PREFERABLE fig.30)
D · BATHTUB DRAIN
Ɛ · SOIL STACK
F · STACK VENT

DRAINS FOR A STACK VENTED BATHROOM GROUP

Fig. 29



DRAINAGE & SEWERAGE SYSTEM

Fig. 30

asbestos or tar impregnated cellulose fibre. The last two named are somewhat easier to lay, since the joints are merely slipped together.

In laying tile start from the bottom end of the trench. Lay the pipe with the bell upstream. Fill in the lower one-third of the bell with a mix of two parts sand, one part cement and only enough water to make a stiff mix. Place the spigot of the next pipe in the bell, making certain the spigot is on top of the cement mortar. Fill in the remainder of the joint with cement mortar and bevel the outside of the joint. Wipe out the inside of the pipe with a burlap sack. This is important since a small amount of mortar at the joint inside the pipe will cause the pipe to plug up when in use.

Water Supply

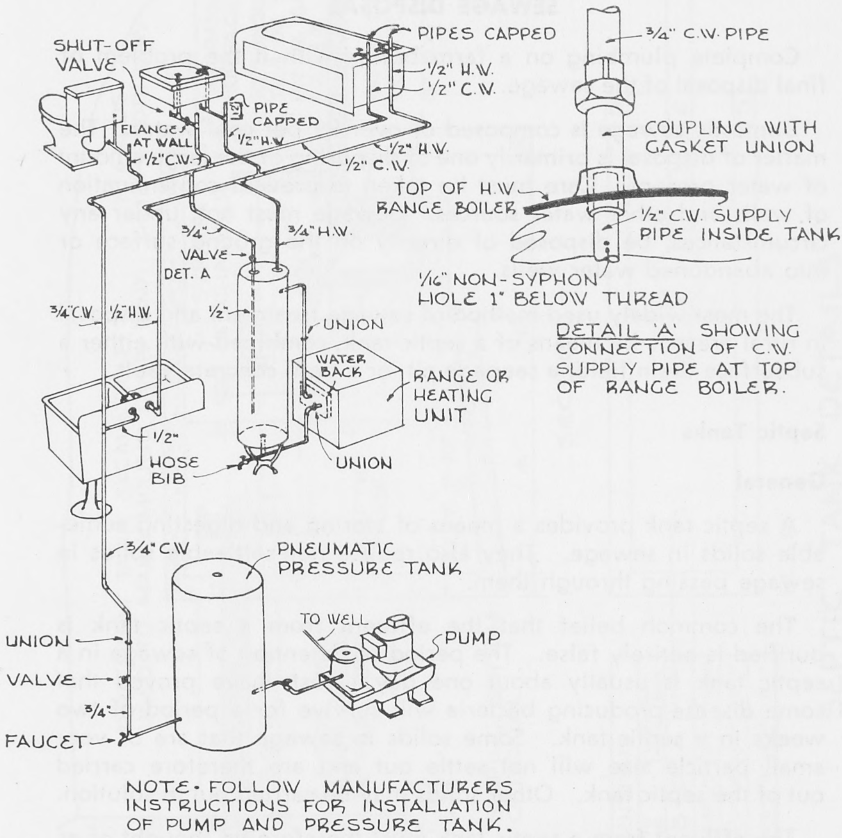
Pipes leading from the well to the house should be of copper or plastic to prevent corrosion. Galvanized iron corrodes quite rapidly in some areas in the Prairie Provinces. Therefore if it is used it should be enclosed in a 4 inch weeping tile. This type of construction will minimize corrosion, and make it possible to remove the pipe if necessary without digging. Put in a union at the well and in the basement to facilitate removal of the pipe.

Water lines should be placed at least 7 feet below ground for protection against freezing. If there are paths over the water line a depth of 8 or 9 feet is preferable. Backfilling in the trenches should be well compacted to give protection against freezing. Frost penetration is greater in gravel and sand than in clay backfilling.

The inside plumbing for the water supply requires no detailed instructions for installations. Joints should be carefully made, ragged edges filed off pipe ends, and pipe dope applied to the male threads. The horizontal piping should slope upwards to the taps so as to avoid air traps, and to facilitate drainage. (Fig. 31).

A shower bath may be economically installed over a bath tub. It will require, on the average, less water per bath than a tub. The shower head should be six feet three inches above the floor, for average users. If it is felt that a shower may be installed over a bath tub at a later date, tees should be installed at the water lines and a screwed plug put in the tee. This plug can then be taken out and replaced by water lines to the shower head.

The hot water tap should be the left-hand tap in any installation where two taps are present (baths, basins and sinks). A combination swing faucet is very handy at the kitchen sink.



WATER SUPPLY SYSTEM

Fig. 31

The drainage plumbing is best installed by a plumber. The water supply piping may be installed by the home owner without too much difficulty. Working in co-operation with your plumber will assure a good installation which will meet the requirements of your Departments of Health and ensure long trouble-free service.

A pressure test should be made on the supply piping before plastering walls in which piping is concealed.

SEWAGE DISPOSAL

Complete plumbing on a farm brings with it the problem of final disposal of the sewage.

Domestic sewage is composed of over 99 per cent water. The matter of disposal is primarily one of disposing of the large amount of water present. Care must be taken to prevent contamination of wells and other water sources. Sewage must not, under any circumstances, be disposed of directly on the ground surface or into abandoned water wells.

The most widely used method of sewage treatment and disposal in rural areas is by means of a septic tank, combined with either a subsurface drain field, a seepage pit, or a tight concrete vault.

Septic Tanks

General

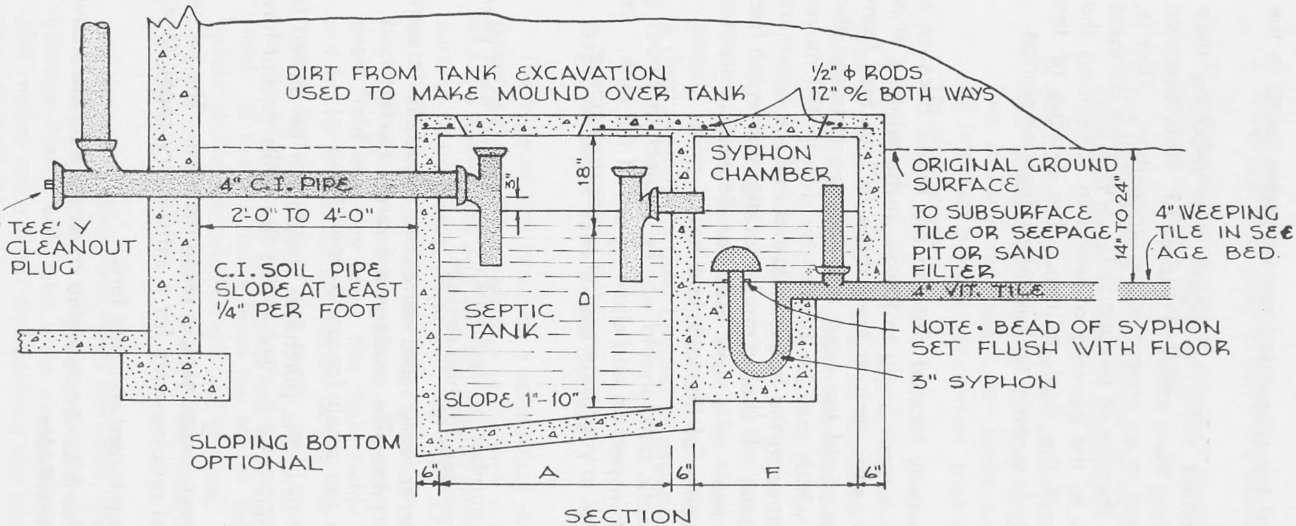
A septic tank provides a means of storing and digesting settleable solids in sewage. They also reduce non-settleable solids in sewage passing through them.

The common belief that the effluent from a septic tank is purified is entirely false. The period of detention of sewage in a septic tank is usually about one day. Tests have proved that some disease-producing bacteria will survive for a period of two weeks in a septic tank. Some solids in sewage that are of very small particle size will not settle out and are therefore carried out of the septic tank. Other solids may be carried out in solution.

The effluent from a septic tank must therefore be thought of as untreated sewage, capable of spreading diseases such as typhoid, paratyphoid, dystentery, and other intestinal diseases.

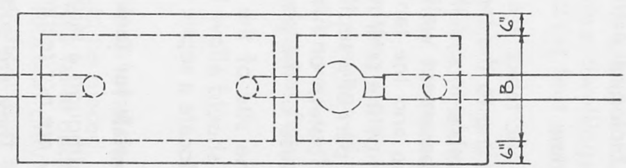
However, a septic tank does serve the following purposes:

1. It allows large particles in sewage to either settle out or float to the surface, thus leaving the effluent in a state in which it can be pumped or absorbed into pervious soil.



SECTION

NUMBER OF PERSONS USING TANK	TANK VOLUME IN IMPER. GALLONS	DIMENSIONS				
		SEPTIC TANK			SYPHON CHAMBER	
		A	B	D	F	CAPACITY
1 - 8	610	7'0"	3'6"	4'0"	3'0"	76 gal
8 - 12	900	8'0"	4'0"	4'6"	3'0"	88 "
12 - 16	1120	10'0"	4'0"	4'6"	3'9"	110 "



PLAN

SEPTIC TANK DETAILS

Fig. 32

2. It digests some of the suspended non-settleable solids in the sewage.

3. It allows the settled solids to digest, thus reducing their volume and making them easier to dispose of. This digestion process is referred to as anaerobic decomposition. That is, digestion in the absence of oxygen (air). One may compare sludge digestion to the burning of wood in comparing the initial volume and the final volume. The residue of the biological activity in a septic tank is called digested sludge.

Location

Septic tanks are usually located close to the house because a long line to the tank is more likely to freeze in the winter. It is advisable to put the septic tank at least three to four feet from the basement wall to avoid too rigid a connection between the house and the tank which may be broken by differential movement of the tank relative to the house. Do not make a basement wall part of a septic tank. It should not be located within ten feet of a cistern or fifty feet* of a well used for domestic purposes because of the possibility of the tank leaking.

The site of the septic tank should not be subject to flooding and should allow for inspection and cleaning out of the tank. Do not locate a septic tank in your basement or under your house.

Materials for Tank

Although a large number of steel tanks are installed each year, they are not recommended for two reasons.

1. They are subject to very rapid corrosion, especially in some western soils. Protective coatings are rarely perfect.

2. They are often too small for good operation.

If buying a steel tank, the purchaser should not be misled by claims of high efficiency, or the claim that the tanks do not have to be cleaned out.

A reinforced concrete septic tank is recommended. The following are the essential requirements for a satisfactory septic tank:

1. A watertight reinforced concrete tank.

2. A removable plank or concrete slab cover, or a concrete cover with suitable manholes.

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*Provincial regulations may vary somewhat.

3. A vertical inlet pipe to carry the sewage down into the tank.

4. A submerged outlet to prevent scum and other solids from passing into the drain field.

5. The inlet pipe 3 inches above the outlet in order to allow for escape of gases formed in digestion.

6. Adequate capacity. For six persons a minimum capacity of 450 imperial gallons in the first chamber, below the flow line is recommended. For tanks serving dwellings allow 35 imperial gallons per person, plus 6 cubic feet per person for sludge storage.

A working diagram of a septic tank is shown in Fig. 32. This type of tank is recommended by the Departments of Health of the three Prairie Provinces. (Recommended size may vary somewhat.)

A septic tank is a permanent part of a plumbing system. Make it large enough to accommodate the largest number of people that will possibly use it. A large tank will function well with a few people using it, but a small tank will ruin a disposal field within a short time if it is used beyond its capacity.

Depth of Septic Tank Below Surface

The type of soil in which a subsurface drainfield will be placed governs the depth at which a septic tank should be placed. If the soil is a heavy clay and will not absorb water (see table under subsurface drain fields, page 71), the field can function only if it is installed close to the surface where evaporation and aerobic bacterial activity can take place. **Do not attempt to put in a deep drain field in a clay soil.** The drain fields in clay soils should be put in 18 inches to 24 inches below the ground surface. This means that the top of the septic tank must be 36 inches above the top of the outlet pipe from the syphon chamber to the drain field. If the ground is level the top of the tank will thus be 18 inches above the original ground surface. It is common practice to put a mound of earth around and over the septic tank in such installations.

If the soil is sandy and fairly pervious, the drain field and septic tank may be installed at greater depths. This may have the advantage that it will take wash water from the basement, but it also means more labor in installing the tank and drain field. A deep drain field and septic tank is not protection against basement flooding.

Operation and Maintenance

In starting a septic tank many people are of the opinion that yeast is required; some even add yeast at regular periods. The digestion process in a septic tank will start itself—no yeast is necessary. Human wastes have a high bacteria content which enter into the digestion process. The process is a slow one. It is comparable to the gradual decay of a manure pile. The process is almost impossible to stop and is very difficult to speed up. If the septic tank is built large enough the starting period will not be long enough to cause plugging of the tank.

As previously stated, the digestion process in a septic tank leaves a residue in the tank. This residue along with the scum in a tank will gradually reduce its effective capacity and will not allow other solids to settle out. If this occurs these solids will be carried out into the drain field thereby cutting down its absorptive capacity. The field will eventually be ruined and the sewage will back up into the tank, where it will overflow onto the ground surface.

For this reason, septic tanks should be opened and cleaned periodically. When first installed it is recommended that the tank be inspected and cleaned out after one or two years of operation. The amount of solids present will then indicate how often the tank should be cleaned out thereafter. The sludge and scum should never be allowed to occupy more than one-quarter of the total capacity of the tank.

Cases are cited of septic tanks operating for as long as twenty years without being cleaned out. In these cases a check-up will show one or more of the following conditions:

1. Very few people use the tank.
2. The disposal field is in very porous and or gravel soil.
3. The effluent flows into a pit which is pumped out at intervals. In this case the septic tank if not cleaned out, performs no useful function, and might as well have never been built.

It is not a good idea to put a septic tank in operation after the ground has begun to freeze. The best time for installation is from May to August. If a tank is put in operation late in the fall, large quantities of hot water should be passed through it for a few weeks.

A septic tank will handle ordinary kitchen wastes without difficulty. However, large quantities of grease should be kept out of the tank.

The question of using drain cleaners is often raised. In a good plumbing installation it is only very rarely that drain cleaners have to be used. If the drain from a sink or basin plugs frequently it is probably installed with too little slope. It should also be checked to see if recessed fittings have been used. The occasional use of a drain cleaner will not harm a septic tank.

Questions are also frequently raised as to the effect of detergents and wetting agents on septic tanks. While these products have dispersing as well as some bactericidal powers it has not been proved to date that they are harmful to septic tanks. There is a possibility that they are detrimental if used in large quantities, the most likely effect being the breaking up of large material into very fine solids which will not settle out and thus pass into the drain field. They may also slow down the digestion process.

The wash water from a zeolite water softener should not be put through a septic tank.

Dosing Syphons

Experience has shown that dosing syphons are a necessary part of a septic tank with a shallow drain field. Even in deep installations a dosing syphon will aid in making full use of a drain field.

If the septic tank is installed below frost line and the effluent flows into a seepage pit or concrete vault there is no need of a dosing syphon.

The usual syphon has a bell-shaped portion which is inverted over the top of a vertical pipe. This bell does not move at any time even when the syphon is in operation. The small air vent or "sniff hole" which is a part of the bell must not be plugged.

The syphon chamber should be inspected at intervals. If large solids, paper, etc., are present in this chamber it is a sign that the main portion of the tank should be cleaned out. Any solids in this chamber will pass out into the drain field and plug it up.

Subsurface Drain Fields

The subsurface drain field is the cheapest in labour and material, and the most satisfactory method of disposing of a septic tank effluent. Different field patterns are shown in Fig. 33. The liquid waste flows into the surrounding soil and it is obvious that the amount of tile necessary will depend upon the ease with which water will flow into the soil. (See page 69).

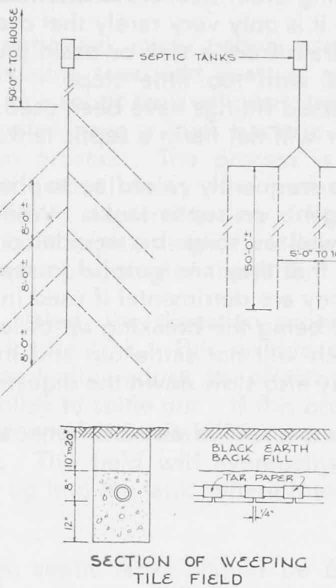


Fig. 33

Material

The material most likely used is glazed tile for the tight portions of the field and unglazed (weeping tile) for the evaporation or seepage bed.

In some areas a preference has been shown for tar impregnated cellulose fibre or cement-asbestos drainage pipe. With these pipes tight joints are easily made and the pipe is more easily laid to grade. The cost is somewhat higher. The bottom of the pipe is perforated so seepage from the pipe can take place.

Location

In locating a drain field care should be taken to avoid having any portion of the field within 100 feet of any well, spring or other source of water used for domestic purposes. Even this distance is not sufficient to avoid contamination of water supplies if the flow toward the well is through gravel or fissured limestone. Provincial sanitary inspectors will offer good advice in this respect.

The drain field should be located so as to avoid any traffic over the field. This is very important in order to avoid freezing in winter. If a footpath or roadway must pass over the section of pipe from the septic tank to the seepage bed, that portion of pipe should be encased with an 8 x 8 box.

The seepage bed may be placed under a lawn or garden, but grass should be kept short so as to promote evaporation. Do not plant trees or hedges over the drain field as the roots will enter and plug the drains.

Care of Drain Field

Heavy equipment such as tractors, should not pass over the field as there is danger of breaking the tile.

Length of Field Tile Necessary

The following table gives the length of field tile necessary. This is the length of tile laid with open joints, or other pipe drilled to allow seepage.

NATURE OF SOIL	Length of Tile Required per Person
Sand or light loam	20 ft.
Fine sand with some clay or loam	30 ft.
Clay with some sand or gravel	80 ft.

In heavy clay soils a deep seepage bed will not work. However by installing a shallow field with adequate quantities of gravel and backfilling the trenches with black pervious topsoil, many installations have been successful. They depend largely on evaporation (see Fig. 32), and seem to operate best with a cover of only 18 inches.

An alternate method is the installation of a sand filter. (Fig. 34). The effluent from this type of installation may then be run into a surface ditch or coulee. This type of installation is not possible in villages and towns, and requires the approval of the Department of Health.

If there is some doubt as to the character of the soil a percolation test may be run. Dig a hole approximately one foot square down to the depth at which the drains are to be installed. Fill the hole with water to a depth of two feet and allow the water to seep away. While the bottom of the hole is still moist fill the hole with water to a depth of six inches, and observe the time it takes for the water to fall one inch. Use the following table to determine the length of title field required.

Time for Water to Fall One Inch	Approx. Length of 4 Inch Tile Required per Person
5 minutes	20 ft.
10 minutes	30 ft.
30 minutes	60 ft.
60 minutes	80 ft.

While the lengths of field tile recommended in the above table may be used, it is common practice to use a minimum of 180 feet of open field tile in any installation.

Construction Features

If a dosing syphon is used the whole field should be laid level. Where no syphon is used the main line to the disposal field should be laid on a uniform slope of ⅛ inch per foot and the lateral drains (open joints) on a grade of 1/16 inch per foot. If the natural ground surface has a steep grade a field pattern such as shown in Fig. 34 should be installed.

Where unglazed tile is used it should be spaced ¼ inch between sections. Tar paper is placed over these joints so as to prevent gravel and dirt from falling to the tile. (See Fig. 33).

The trenches for the fields are dug from 18 to 24 inches wide and from 30 to 36 inches deep. They are filled to a depth of 12 inches with gravel ¼ to 1 inch in diameter This gravel should contain no sand. The gravel is tamped to form a firm base for the tile. After the tile is laid and the joints covered with tar paper, coarse gravel is put into the trench to a depth of 4 inches above the top of the tile. The remainder of the trench is backfilled with black pervious top soil, **not** clay. (Fig. 33).

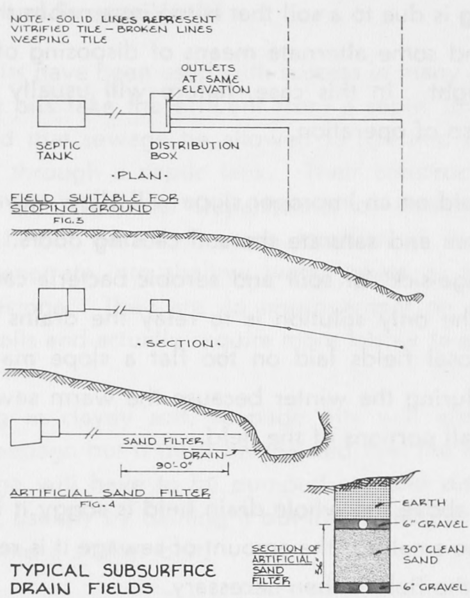


Fig. 34

Septic Tank and Field Troubles

Clogging of the disposal field is the most common trouble in farm sewage disposal systems. This may result from one or more of the following causes:

1. A tank that is too small.
2. Failure to clean out the septic tank.
3. Poor arrangements of inlets and outlets to tank, which prevents the sewage from settling.
4. A disposal field that is too small.
5. Disposal field drains placed in a clay soil.

If a drain field is clogged due to any but the last reason, it is sometimes possible to dig up the ends of the field and flush it out with a hose. After a period of rest the field may be used again after adding extensions to it, or the tile may be dug up, cleaned out and relaid in new trenches three to four feet from the old ones.

If plugging is due to a soil that is too impervious this procedure is useless, and some alternate means of disposing of the sewage must be sought. In this case, failure will usually occur in the first year or so of operation.

Field tile laid on an improper slope will allow sewage to collect in a small area and saturate the soil causing odors. This soil becomes "sewage-sick' 'or sour and aerobic bacteria cannot work in such soil. The only solution is to relay the drains on a correct slope. Disposal fields laid on too flat a slope may also result in freezing during the winter because the warm sewage will not penetrate to all portions of the field.

If the soil above the whole drain field is soggy it indicates that the field is too small for the amount of sewage it is receiving. An extension of the field is then necessary.

Freezing of Field Tile

Freezing of subsurface field drains is usually due to one of the following reasons:

1. Insufficient use (especially with warm water as from baths and laundry).
2. Traffic over the drain field (even footpaths) causing deep frost penetration.
3. Installation in late fall in cold weather with loose or frozen backfill soil.

It is a good policy to cover the drain field with straw, and also allow snow to accumulate on it. Freezing is not due to insufficient bacterial action in the septic tank. A pailful of hot water contains more heat than that supplied by bacterial action in a septic tank over a number of weeks.

Seepage Pits and Sewage Vaults

Seepage pits have been used with success in many rural installations. These pits take the effluent from a septic tank. It is not recommended that sewage be allowed to run into a pit without first passing through a septic tank. Their construction requires approval by the Provincial Departments of Health. They can constitute a health hazard in some localities if they are deep enough to penetrate into shallow water tables or formations of fissured limestone. They are no improvement on a drain field in pervious soils and actually require more labour to construct.

When dug in clayey soil, seepage pits will allow a certain amount of seepage but it must be realized that the major portion of the sewage will have to be pumped out and disposed of by other means, usually by hauling it out into a field or by pumping the sewage into a shelter belt.

Sewage pumped onto the ground surface occasionally is not the constant menace to health produced by indiscriminate continual flow onto a ground surface. The sewage will be absorbed by the topsoil and evaporate in a few days. Do not irrigate gardens with the contents of a seepage pit. This applies especially to any vegetables eaten raw (lettuce, carrots, cabbage, etc.).

Seepage pits are more often used for disposal of wastes in cases where a kitchen sink is installed but no toilet is present. They are also used to dispose of wash water waste from the regeneration of zeolite softeners. Such waste water will kill trees and grass because of its high salt content.

When seepage pits are constructed in pervious soil the liquids will seep into the ground. In such cases they may be filled with field stones and require no lining.

In clay soils with low organic content where the pit will have to be pumped out do not fill the pit with stone. This will only reduce the effective capacity and decrease the time between pumping out of the pit.

In this case it is wise to put in some form of cribbing, so that the sides will not cave in. If the pit is to be pumped out, a fairly large size is desirable to provide enough storage to go through the cold months when pumping is a troublesome task. A size of about 12 feet square by 12 feet deep is suggested.

A square pit or a pit of cubical proportions, i.e. width, length, and depth equal, is the most economical shape to construct. A circular pit requires even less material for walls, for a given capacity but may be more difficult to construct.

Seepage pits or vaults should have a good cover on them to prevent accidents, and to prevent freezing.

COST OF INSTALLATIONS

The cost of installing running water and sewage disposal on a farm is somewhat higher than that of similar urban installations. This is due to the cost of the storage (pneumatic tank or gravity tank), the cost of a motor or engine, and the cost of building a septic tank.

While the initial cost may be higher, the cost of water supplied over a number of years is often less in farm than in urban installations.

Very roughly fifty percent of the total cost is labour. If you are going to have the system installed for you, double the cost of the materials to get an estimate of total cost.

Note—A bulletin by the same author entitled "Treatment of Farm Water Supplies" deals with the topic implied in the title.

OTHER PUBLICATIONS

The following publications are prepared under the same auspices and are available from the same sources as this one:

FARM KITCHENS & UTILITY ROOMS

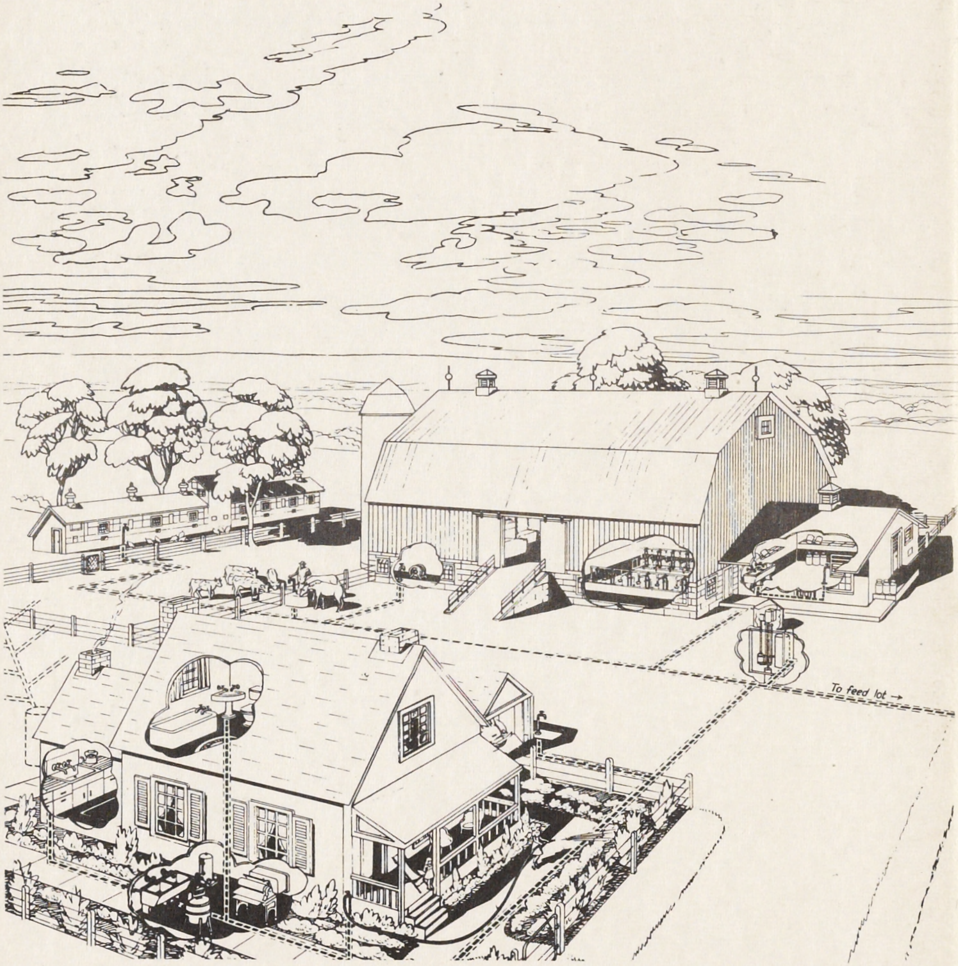
TWENTY FARM HOUSE PLANS

TREATMENT OF FARM WATER SUPPLIES

FARM HOUSE REMODELLING

WATER

WHERE YOU WANT IT
WHEN YOU WANT IT



This illustration courtesy of Beattie Bros. Ltd., Fergus, Ont.